Streamflow and Water-Quality Data for Selected Watersheds in the Lake Tahoe Basin, California and Nevada, Through September 1998

By Timothy G. Rowe[1], Dina K. Saleh[2], Sharon A. Watkins[1], *and* Charles R. Kratzer[3]

[1] U.S. Geological Survey, Carson City, Nevada.
[2] California State University, Sacramento, California.
[3] U.S. Geological Survey, Sacramento, California.

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 02-4030

Prepared in cooperation with the
LAHONTAN REGIONAL WATER QUALITY CONTROL BOARD
TAHOE REGIONAL PLANNING AGENCY
UNIVERSITY OF CALIFORNIA, DAVIS

Carson City, Nevada
2002

Cover photograph: Incline Creek inflow to Lake Tahoe, looking south from mouth near Incline Village, Nev., June 1999. Photograph by Timothy G. Rowe, U.S. Geological Survey.

U.S. DEPARTMENT OF THE INTERIOR
GALE A. NORTON, Secretary

U.S. GEOLOGICAL SURVEY
CHARLES G. GROAT, Director

For additional information contact:

District Chief
U.S. Geological Survey
333 West Nye Lane, Room 203
Carson City, NV 89706–0866

email: GS-W-NVpublic-info@usgs.gov

home page: http://nevada.usgs.gov

CONTENTS

APPENDICES

FIGURES

TABLES

CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
acre feet (acre-ft)	0.001233	cubic hectometer
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter
inch (in.)	25.4	millimeter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
kilogram (kg)	2.205	pounds
kilogram per square kilometer (kg/km^2)	5.712	pounds per square mile

Water-Quality Units:

microgram per liter	(µg/L)
microsiemens per centimeter	(µS/cm)
milligrams per liter	(mg/L)
kilograms per month	(kg/mo)
kilograms per square kilometers per month	(kg/km^2/mo)

Temperature: Degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) by using the formula °F = [1.8(°C)] + 32. Degrees Fahrenheit can be converted to degrees Celsius by using the formula °C = 0.556(°F - 32).

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929, formerly called "Sea-Level Datum of 1929"), which is derived from a general adjustment of the first-order leveling networks of the United States and Canada. NOTE: U.S. Bureau of Reclamation datum for the surface-water elevation of Lake Tahoe is 1.14 feet higher than the National Geodetic Vertical Datum of 1929.

Streamflow and Water-Quality Data for Selected Watersheds in the Lake Tahoe Basin, California and Nevada, Through September 1998

By Timothy G. Rowe[1], Dina K. Saleh[2], Sharon A. Watkins[1], *and* Charles R. Kratzer[3]

ABSTRACT

The U.S. Geological Survey, in cooperation with the Tahoe Regional Planning Agency, and the University of California, Davis–Tahoe Research Group, has monitored tributaries in the Lake Tahoe Basin since 1988. This monitoring has characterized streamflow and has determined concentrations of nutrients and suspended sediment, which may have contributed to loss of clarity in Lake Tahoe. The Lake Tahoe Interagency Monitoring Program was developed to collect water-quality data in the basin. In 1998, the tributary-monitoring program included 41 water-quality stations in 14 of the 63 watersheds totaling half the area tributary to Lake Tahoe. The monitored watershed areas range from 1.08 square miles for First Creek to 56.5 square miles for the Upper Truckee River.

Annual and unit runoff for 20 primary and secondary streamflow gaging stations in 10 selected watersheds are described. Water years 1988–98 were used to compare runoff data. The Upper Truckee River at South Lake Tahoe, Calif., had the highest annual runoff and Logan House Creek near Glenbrook, Nev., had the lowest. Blackwood Creek near Tahoe City, Calif., had the highest unit runoff and Logan House Creek had the lowest. The highest instantaneous peak flow was recorded at Upper Truckee River at South Lake Tahoe during the January 2, 1997, flood event.

Certain water-quality measurements were made in the field. Ranges and median values of those measurements are described for 41 stations. Water temperature ranged from 0 to 23°C. Specific conductance ranged from 13 to 900 microsiemens per centimeter at 25°C. pH ranged from 6.7 to 10.6. Dissolved-oxygen concentrations ranged from 5.2 to 12.6 mg/L and from 70 to 157 percent of saturation.

Loads, yields, and trends of nutrients and suspended sediment during water years 1988–98 at the streamflow gaging stations also are described. The Upper Truckee River at South Lake Tahoe had the largest median monthly load for five of the six measured nutrients and of suspended sediment, while Trout Creek at South Lake Tahoe had the largest median monthly load for the remaining nutrient. Logan House Creek near Glenbrook had the smallest median monthly loads for all nutrients and suspended sediment. Seasonal load summaries at selected stations showed nutrient and suspended-sediment loads were greatest in the spring months of April, May and June and least in the summer months of July, August, and September. Monthly load comparisons also were described for five watersheds with multiple stations.

Incline Creek had the highest combined rank for all nutrients and sediment. Incline Creek had the largest monthly yields for dissolved nitrite plus nitrate nitrogen and soluble reactive phosphorus. Third Creek had the second highest combined rank and had the largest monthly yields for total nitrogen, total phosphorus, biologically reactive iron,

[1] U.S. Geological Survey, Carson City, Nevada.
[2] California State University, Sacramento, California.
[3] U.S. Geological Survey, Sacramento, California.

and suspended sediment. Edgewood Creek had the largest monthly yield for dissolved ammonia nitrogen. Logan House Creek had the lowest combined rank and the smallest monthly yields for all nutrients and sediment.

Trends in concentrations are either decreasing or not significant for all nutrients in all sampled watersheds, with the exception of biologically reactive iron. Biologically reactive iron and suspended sediment show an increasing trend in three watersheds and decreasing or no significant trend in the other seven watersheds.

INTRODUCTION

Since the early 1970's, monitoring stream water quality in the Lake Tahoe Basin has been done by the Tahoe Regional Planning Agency (TRPA), the U.S. Geological Survey (USGS), the Tahoe Research Group (TRG) of the University of California at Davis, and State and local agencies. The Lake Tahoe Interagency Monitoring Program (LTIMP) was began in 1978 and described in Rowe (2000), Boughton and others (1997), and Rowe and Stone (1997). A tributary-monitoring program, a cooperative effort by TRPA, USGS, and TRG, began in water year 1988 and continues currently (2002). Fourteen of the 63 watersheds in the Lake Tahoe Basin (fig. 1) are monitored in the LTIMP network including a total of 41 tributary stations (table 1).

Data collected from the LTIMP network stations include streamflow, water-quality parameters, nutrients, and sediment (table 2). Schedules for sampling were determined by the type of station (primary, secondary, or miscellaneous). A primary station has a continuous streamflow gage and 25–40 water-quality samples are collected annually at near mouth locations in 10 watersheds. A secondary station has a continuous streamflow gage and 20–30 water-quality samples are collected annually at 10 multiple-station sites in 5 of 10 watersheds. Samples are collected from primary and secondary stations during monthly baseline periods and runoff events. A miscellaneous station is a sampling station, urban-runoff sampling station, or water-temperature network station. The 12 miscellaneous sampling stations are ungaged and 6–10 water-quality samples are collected annually (mainly during snowmelt and storm-runoff periods). Sampling at the three station types was emphasized during spring snowmelt, rain-on-snow events, summer thunderstorms, and fall rain events, whether they occurred during day or night.

Background

Lake Tahoe is within the crest of the Sierra Nevada Range and lies within the states of California and Nevada (fig. 1). Lake Tahoe is described as an outstanding natural water resource and is famous for its alpine setting and deep, clear waters. Protection of these clear waters has become very important in the past half century, because water clarity has been decreasing by about 1 ft/yr (Goldman and Byron, 1986). This decrease in clarity is mainly due to human activities, which have increased dramatically in the Lake Tahoe Basin since 1960.

Increased nutrient concentrations within Lake Tahoe are considered the primary cause of algal growth, and thereby loss of lake water clarity. Suspended sediment also is of concern, because nutrients attach to and are transported by sediment particles. Within the Lake Tahoe Basin, one of the major pathways for nutrient and sediment transport to the lake is streamflow. Transport of those materials has been accelerated progressively by development activities such as urbanization of wetlands and steeply sloping terrain around the lake margin.

Public concern for the clarity of Lake Tahoe has increased over the years. In 1986 and 1996, voters in Nevada passed bond acts to fund construction projects to reduce erosion and the transport of nutrients and sediments to Lake Tahoe in the Nevada portion of the Lake Tahoe Basin. The Lake Tahoe Interagency Monitoring Program (LTIMP) was developed to collect water-quality data in the basin. LTIMP water-quality data and streamflow data are available to the public through several USGS internet web sites (app. 1).

Acknowledgements

Dr. John Reuter, Patty Arneson, and Loren Hatch, all of the University of California at Davis, contributed long-term nutrient data.

Table 1. Information for current USGS LTIMP primary and secondary surface-water quality sampling/gage stations and miscellaneous water-quality stations in the Lake Tahoe Basin, California and Nevada

[Abbreviations: mi, miles; mi^2, square miles; ft^3/s, cubic feet per second; ND, not determined; Misc., miscellaneous]

Map number	Station name	Station number	Latitude	Longitude	Type of station	Drainage area (mi^2)	Altitude (feet above sea level)	Distance from mouth (mi)	Channel length (mi)	County
				Incline Village area (fig. 2)						
1	First Creek (at Highway 28) near Crystal Bay, Nev.	10336688	39°15′00″	119°59′18″	Misc.	1.07	6,280	0.08	2.26	Washoe
2	Second Creek at Lakeshore Dr. near Crystal Bay, Nev.	10336691	39°14′58″	119°58′35″	Misc.	1.37	6,250	.02	3.02	Washoe
3	Wood Creek near mouth (at Lakeshore Dr.) near Crystal Bay, Nev.	10336694	39°14′35″	119°57′30″	Misc.	1.97	6,250	.02	3.94	Washoe
4	Wood Creek above Jennifer St. near Incline Village, Nev.	10336692	39°15′46″	119°57′38″	Misc.	1.30	6,880	1.71	2.25	Washoe
5	Third Creek (at Lakeshore Dr.) near Crystal Bay, Nev.	10336698	39°14′26 ″	119°56′44″	Primary	6.02	6,240	.13	6.92	Washoe
6	Third Creek at Village Blvd. at Incline Village, Nev.	103366965	39°15′47″	119°56′39″	Misc.	4.48	6,720	1.84	5.21	Washoe
7	Third Creek below unnamed tributary near Incline Village, Nev.	103366958	39°16′47″	119°56′46″	Misc.	4.32	7,350	3.04	4.01	Washoe
8	Incline Creek (above Lakeshore Dr.) near Crystal Bay, Nev.	10336700	39°14′25″	119°56′38″	Primary	6.69	6,240	.17	4.49	Washoe
9	Incline Creek at Highway 28 at Incline Village, Nev.	103366995	39°14′44″	119°56′17″	Secondary	4.54	6,320	.86	3.80	Washoe
10	Incline Creek above Tyrol Village near Incline Village, Nev.	103366993	39°15′32″	119°55′20″	Secondary	2.85	6,920	1.86	2.80	Washoe
11	Incline Creek Tributary at County Club Dr. near Incline Village, Nev.	103366997	39°15′52″	119°56′32″	Misc.	1.01	6,760	1.76	1.20	Washoe
				Glenbrook area (fig. 3)						
12	Glenbrook Creek (near mouth) at Glenbrook, Nev.	10336730	39°05′15″	119°56′20″	Primary	4.10	6,240	.09	3.83	Douglas
13	Glenbrook Creek at Old Highway near Glenbrook, Nev.	10336725	39°05′12″	119°55′51″	Misc.	3.75	6,320	.48	3.44	Douglas
14	Logan House Creek near Glenbrook, Nev.	10336740	39°04′00″	119°56′04″	Primary	2.09	6,640	.30	3.00	Douglas
15	North Logan House Creek at Highway 50 near Glenbrook, Nev.	10336735	39°04′08″	119°56′24″	Misc.	1.08	6,410	.10	1.70	Douglas
16	Edgewood Creek at Lake Tahoe near Stateline, Nev.	10336765	38°58′05″	119°56′54″	Misc.	6.57	6,240	.01	5.52	Douglas

Table 1. Information for current USGS LTIMP primary and secondary surface-water quality sampling/gage stations and miscellaneous water-quality stations in the Lake Tahoe Basin, California and Nevada—Continued

Map number	Station name	Station number	Latitude	Longitude	Type of station	Drainage area (mi^2)	Altitude (feet above sea level)	Distance from mouth (mi)	Channel length (mi)	County
				Stateline area (fig. 4)						
17	Edgewood Creek Tributary above Edgewood Clubhouse near Stateline, Nev.	385758-119564401	38°57′58″	119°56′44″	Misc. urban	0.47	6,240	0.23	1.80	Douglas
18	Culvert—Highway 50 runoff into Edgewood Creek—left bank, upstream, Highway 50, Nev.	385758-119561101	38°57′58″	119°56′11″	Misc. urban	ND	6,270	.00	ND	Douglas
19	Edgewood Creek (at Highway 50) at Stateline, Nev.	10336760	38°57′58″	119°56′10″	Primary	5.61	6,270	.86	4.67	Douglas
20	Edgewood Creek at Palisade Dr. near Kingsbury, Nev.	103367585	38°58′00″	119°54′54″	Secondary	3.13	6,640	1.63	3.90	Douglas
21	Eagle Rock Creek near Stateline, Nev.	103367592	38°57′24″	119°55′36″	Secondary	.63	6,480	.25	1.20	Douglas
22	Edgewood Creek Tributary near Daggett Pass, Nev.	10336756	38°58′32″	119°54′00″	Misc.	.80	7,000	1.10	1.40	Douglas
23	Edgewood Creek below South Benjamin Dr. near Daggett Pass, Nev.	10336750	38°58′00″	119°53′37″	Misc.	.73	7,160	3.76	1.77	Douglas
				South Lake Tahoe area (fig. 5)						
24	Trout Creek near mouth—east near Bellevue/ El Dorado Ave.	10336795	38°56′12″	119°59′23″	Misc. temperature	41.0	6,230	.10	12.1	El Dorado
25	Trout Creek (at Highway 50) at South Lake Tahoe, Calif.	10336790	38°55′56″	119°58′40″	Primary (sample)	40.4	6,240	1.50	10.7	El Dorado
26	Trout Creek (at Martin Ave.) near Tahoe Valley, Calif.	10336780	38°55′12″	119°58′17″	Primary (gage)	36.7	6,240	2.75	9.45	El Dorado
27	Cold Creek at mouth near South Lake Tahoe, Calif.	10336779	38°54′44″	119°58′06″	Misc. temperature	12.8	6,260	.01	7.95	El Dorado
28	Trout Creek at Pioneer Trail near South Lake Tahoe, Calif.	10336775	38°54′13″	119°58′04″	Secondary	23.1	6,270	4.10	8.10	El Dorado
29	Trout Creek at USFS Rd. 12N01 near Meyers, Calif.	10336770	38°51′48″	119°57′26″	Secondary	7.41	6,850	9.20	3.00	El Dorado
30	Upper Truckee River at mouth near Venice Dr. near South Lake Tahoe, Calif.	10336612	38°56′04″	119°59′57″	Misc. temperature	56.5	6,230	.10	21.3	El Dorado

Table 1. Information for current USGS LTIMP primary and secondary surface-water quality sampling/gage stations and miscellaneous water-quality stations in the Lake Tahoe Basin, California and Nevada—Continued

Map number	Station name	Station number	Latitude	Longitude	Type of station	Drainage area (mi^2)	Altitude (feet above sea level)	Distance from mouth (mi)	Channel length (mi)	County
				Stateline area (fig. 4)						
31	Upper Truckee River (at Highway 50) at South Lake Tahoe, Calif.	10336610	38°55′21″	119°59′22″	Primary	54.0	6,230	1.70	19.7	El Dorado
32	Upper Truckee River at Highway 50 bridge below Meyers, Calif.	103366098	38°52′32″	120°00′16″	Misc. temperature	50.1	6,280	5.40	16.0	El Dorado
33	Upper Truckee River at Highway 50 above Meyers, Calif.	103366092	38°50′55″	120°01′34″	Secondary	39.3	6,310	9.40	12.0	El Dorado
34	Upper Truckee River near Meyers, Calif.	10336600	38°50′35″	120°01′24″	Discontinued gage	33.2	6,320	10.0	11.4	El Dorado
35	Grass Lake Creek (at Grass Lake Rd.) near Meyers, Calif.	10336593	38°48′06″	120°00′54″	Misc.	6.35	6,480	.05	5.45	El Dorado
36	Upper Truckee River at South Upper Truckee Rd. near Meyers, Calif.	10336580	38°47′47″	120°01′05″	Secondary	14.2	6,490	17.4	4.00	El Dorado
				Tahoe City to Meeks Bay area (fig. 6)						
37	General Creek (at Highway 89) near Meeks Bay, Calif.	10336645	39°03′07″	120°07′03″	Primary	7.39	6,250	.04	9.13	El Dorado
38	Blackwood Creek (at Highway 89) near Tahoe City, Calif.	10336660	39°06′27″	120°09′40″	Primary	11.1	6,240	.08	6.12	Placer
39	Ward Creek at State Highway 89 near Tahoe Pines, Calif.	10336676	39°07′56″	120°09′24″	Primary	9.73	6,230	.25	5.65	Placer
40	Ward Creek at Stanford Rock Trail crossing near Tahoe City, Calif.	10336675	39°08′13″	120°10′48″	Secondary	8.97	6,440	1.50	4.40	Placer
41	Ward Creek below confluence near Tahoe City, Calif.	10336674	39°08′27″	120°12′40″	Secondary	4.96	6,600	3.50	2.40	Placer

Table 2. LTIMP surface-water sample analysis; constituents, abbreviations, parameter codes, and reporting levels

[Total nitrogen = total organic plus ammonia nitrogen (TKN) plus dissolved nitrite plus nitrate ($NO_2 + NO_3$); soluble reactive phosphorus (SRP) = dissolved orthophosphate phosphorus. Abbreviations: mg/L, milligrams per liter; µg/L, micrograms per liter; °C, degrees Celsius; ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter]

Constituent	Abbreviation	Parameter code	Reporting level
Nutrients			
Dissolved nitrite plus nitrate nitrogen	$NO_2 + NO_3$	00631	0.002 mg/L
Dissolved ammonia nitrogen	NH_4	00608	0.003 mg/L
Total organic plus ammonia nitrogen (Kehldahl)	TKN	00625	0.035 mg/L
Soluble reactive phosphorus	SRP	00671	0.001 mg/L
Total phosphorus	TP	00665	0.002 mg/L
Biologically reactive iron	BFe	46568	3.0 µg/L
Sediment			
Suspended-sediment concentration	SS	80154	1 mg/L
Suspended-sediment discharge	SSQ	80155	0.01 tons/day
Sand break (higher suspended-sediment concentrations only)		70331	1 percent finer
Field Measurements			
Water temperature	WT	00010	0.5°C
Air temperature	AT	00020	0.5°C
Gage height	GH	00065	0.01 ft
Instantaneous discharge	Q	00061	0.01 ft^3/s
Specific conductance	SC	00095	1 µS/cm
pH		00400	0.1 units
Dissolved oxygen	DO	00300	0.1 mg/L
Barometric pressure	BP	00025	1 mm
Dissolved oxygen (saturation, percent)	DO%	00301	1 percent
Weather (clear, cloudy, rain, snow, thunderstorm)		00041	
Hydrologic event (routine, storm, snowmelt)			
Stage conditions (stable, rising, falling)			
Sample method (equal width increment, dip)		82398	
Sampler type (depth-integrated, handheld 48/81/59; depth-integrated 74)		84164	
Sample collecting agency		00027	
Sample analyzing agency		00028	

Purpose and Scope

This report presents summaries of the streamflow, water-quality, and nutrient and suspended-sediment concentrations data for 41 selected tributary stations in 14 watersheds. Estimated monthly loads, yields, and trends for nutrients and suspended sediment also are presented for 20 sampling stations in 10 watersheds in the Lake Tahoe Basin. These estimates were derived using concentration and daily streamflow data combined from the LTIMP study (water years 1988–98; from October 1, 1987, to September 30, 1998) and from previous monitoring data. All annual data used in this report are based on water years. Estimations of load are reported here only when daily streamflow records exist. Comparisons between the 10 watersheds and within watershed comparisons in 5 multiple-site watersheds also are presented.

ENVIRONMENTAL SETTING

The elevation of Lake Tahoe, averaging about 6,224 ft above sea level, is greater than any other lake of its size in the United States. The maximum length and width of the lake is about 22 mi by 12 mi. The level of Lake Tahoe is controlled by a 6-ft high dam at the Truckee River outlet. A Federal Court Decree limits the maximum permissible elevation of Lake Tahoe to 6,229.1 ft, U.S. Bureau of Reclamation (BOR) datum, which equals 6,227.96 ft above sea level. The USGS water-level gage at Tahoe City, Calif., records lake-surface elevation; the maximum recorded level was 6,231.26 (BOR datum) in July 1907 and the minimum recorded level was 6,220.26 ft (BOR datum) on November 30, 1992. The average depth of the lake is 1,000 ft and the greatest depth is about 1,636 ft (Smith and others, 1999). The total Lake Tahoe Basin area is 506 mi^2, consisting of 192 mi^2 in lake-surface area and 314 mi^2 in surrounding watershed area, and has a drainage perimeter of 138 mi (Cartier and others, 1995, plate).

The 14 watersheds monitored in this study represent half of the Lake Tahoe Basin watershed land area at 157 mi^2, with an average area per watershed of 11.2 mi^2. The remaining 49 unmonitored watersheds also cover 157 mi^2 with an average area per watershed of 3.2 mi^2. Specific watershed information for the 14 monitored watersheds derived from Cartier and others (1995) is listed in table 3. The drainage area of the selected watersheds ranges from 1.08 mi^2 for First Creek to 56.5 mi^2 for the Upper Truckee River. Drainage perimeters range from 5.60 mi for North Logan House Creek to 53.9 mi for Upper Truckee River. The mainstream channel lengths range from 2.34 mi for First Creek to 21.4 mi for the Upper Truckee River; channel elevations range from 6,229.1 ft (maximum lake level) to 9,170 ft for Third Creek. The maximum basin elevation (10,890 ft) occurs in the Trout Creek watershed. General Creek and North Logan House Creek have the largest areas in the lower elevation groups from 6,229 to 8,000 ft (Jeton, 1999, fig. 5). Third Creek watershed has the largest area in the highest elevation groups from about 9,000 to 11,000 ft.

Subdivided areas

The 14 watersheds monitored in the LTIMP study were subdivided into 5 areas: Incline Village, Nev. (northeast), Glenbrook, Nev. (east), Stateline, Nev. (southeast), South Lake Tahoe, Calif. (south), and Tahoe City to Meeks Bay, Calif. (west). Monitoring stations in each of the areas are shown in figures 2–6.

The Incline Village (northeast) area has 11 sampling stations (2 primary, 2 secondary, and 7 miscellaneous; fig. 2). Features in the Incline Village area that might affect stream water quality include Highways 28 and 431 (Mt. Rose Highway), concentrated development in the lower elevations, two golf courses, and one ski resort. Incline Lake in the Third Creek watershed is the largest impoundment in the area and some diversions from upper Third Creek to Ophir Creek can occur at times. Geology in this area consists mainly of intrusive igneous rocks and unconsolidated sediments with some volcanic rocks (fig. 7; Cartier and others, 1994).

The Glenbrook (east) area has four sampling stations (two primary and two miscellaneous; fig. 3). Features in the Glenbrook area that might affect stream water quality include U.S. Highway 50, an old highway route, previous logging activities, and unpaved logging roads. Within the Glenbrook area, Logan House Creek watershed is largely undeveloped, except for historic logging. Geology in this area consists mainly of intrusive igneous rocks with some volcanic rocks, metamorphic rocks, and unconsolidated sediments (fig. 7).

The Stateline area (southeast) area has eight sampling stations (one primary; two secondary; five miscellaneous which include two urban-runoff stations; fig. 4). Features in the Stateline area that might affect stream water quality include U.S. Highway 50, Nevada State Route 207 (Kingsbury Grade), concentrated

Table 3. Drainage basin information for LTIMP monitored and unmonitored watersheds in the Lake Tahoe Basin, California and Nevada

[Abbreviations: ft, feet; mi, miles; mi^2, square miles. Symbol: <, less than. Note: Data from Jorgenson and others (1978), and Cartier and others (1995)]

Watershed	Drainage area (mi^2)	Drainage perimeter (miles)	Channel length (miles)	Channel altitude range (ft above sea level)	Maximum altitude (ft above sea level)	Drainage area (mi^2)				
						Between 6,228–7,000 ft (percent of total)	Between 7,001–8,000 ft (percent of total)	Between 8,001–9,000 ft (percent of total)	Between 9,001–10,000 ft (percent of total)	Between 10, 001–11,000 ft (percent of total)
First Creek	1.08	5.63	2.34	6,229–8,500	9,270	0.18 (17)	0.39 (36)	0.43 (40)	0.08 (7.0)	0 (0)
Second Creek	1.37	7.23	3.04	6,229–8,840	9,610	0.19 (14)	0.52 (38)	0.41 (30)	0.25 (18)	0 (0)
Wood Creek	1.97	9.27	3.94	6,229–8,080	9,610	0.35 (18)	0.65 (33)	0.69 (35)	0.28 (14)	0 (0)
Third Creek	6.05	15.7	7.05	6,229–9,170	10,340	0.97 (16)	0.78 (13)	2.18 (36)	2.06 (24)	0.06 (1.0)
Incline Creek	6.70	11.8	4.66	6,229–8,400	9,220	1.21 (18)	3.01 (45)	2.41 (36)	0.07 (1.0)	0 (0)
Glenbrook Creek	4.10	10.6	3.92	6,229–7,710	8,810	0.90 (22)	2.67 (65)	0.53 (13)	0 (0)	0 (0)
North Logan House Creek	1.09	5.60	2.53	6,229–7,880	8,560	0.11 (10)	0.94 (86)	0.04 (4.0)	0 (0)	0 (0)
Logan House Creek	2.15	7.23	3.30	6,229–8,240	8,820	0.15 (7.0)	1.29 (60)	0.71 (33)	0 (0)	0 (0)
Edgewood Creek	6.64	13.3	5.53	6,229–7,830	9,590	2.32 (35)	2.99 (45)	1.00 (15)	0.33 (5.0)	0 (0)
Trout Creek	41.2	34.8	12.2	6,229–7,760	10,890	14.4 (35)	7.83 (19)	12.0 (29)	6.59 (16)	0.41 (1.0)
Upper Truckee River	56.5	53.9	21.4	6,229–7,920	10,060	19.8 (35)	16.4 (29)	17.5 (31)	2.83 (5.0)	<0.01 (<1)
General Creek	7.63	17.8	9.17	6,229–7,680	8,720	3.13 (41)	4.20 (55)	0.30 (4.0)	0 (0)	0 (0)
Blackwood Creek	11.2	16.1	6.20	6,229–7,140	8,880	4.14 (37)	5.60 (50)	1.46 (13)	0 (0)	0 (0)

Table 3. Drainage basin information for LTIMP monitored and unmonitored watersheds in the Lake Tahoe Basin, California and Nevada—Continued

Watershed	Drainage area (mi^2)	Drainage perimeter (miles)	Channel length (miles)	Channel altitude range (ft above sea level)	Maximum altitude (ft above sea level)	Drainage area (mi^2)				
						Between 6,228–7,000 ft (percent of total)	Between 7,001–8,000 ft (percent of total)	Between 8,001–9,000 ft (percent of total)	Between 9,001–10,000 ft (percent of total)	Between 10, 001–11,000 ft (percent of total)
Ward Creek	9.75	14.6	5.90	6,229–7,040	8,880	3.90 (40)	4.68 (48)	1.17 (12)	0 (0)	0 (0)
14 monitored watersheds (*average*)	157 (11.2)		86.5 (6.18)	6,229–9,170	10,890	51.7 (33) 3.69	52 (33) 3.71	40.8 (26) 2.91	12.5 (8.0) 0.89	0.47 (<1) 0.03
49 unmonitored watersheds *(average)*	157 (3.20)									
Lake Tahoe watershed area	314				10,890					
Lake Tahoe surface area	192	75.2			6,228					
Lake Tahoe total basin	506	138			10,890					

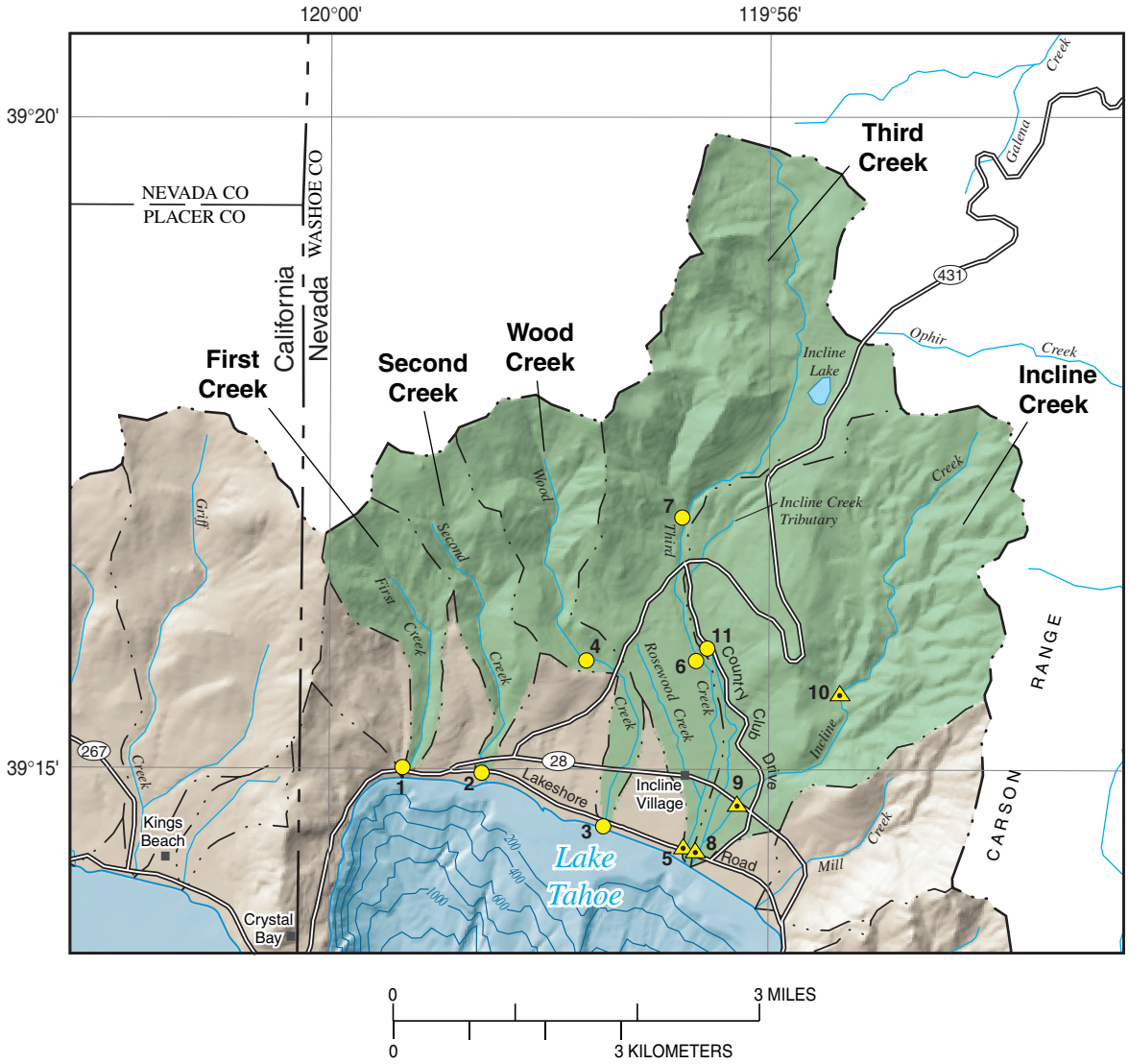

Figure 2. Incline Village area, Nev., and LTIMP sampling stations.

development along Route 207, part of one ski resort, and one golf course. Numerous small ponds along Edgewood Creek, including one just above Edgewood Creek at Stateline, can affect quality of water and streamflow. Geology in this area consists mainly of intrusive igneous rocks and unconsolidated sediments (fig. 7).

The South Lake Tahoe (south) area has 13 stations (2 primary, 4 secondary, 1 discontinued gaging station, and 6 miscellaneous which include 5 water-temperature network stations; fig. 5). Features in the South Lake Tahoe area that might affect stream water quality include U.S. Highway 50, California State Highway 89, Pioneer Trail, many unpaved roads and trails, concentrated development in the lower elevations, one ski area, two golf courses, and reclamation of major wetlands. Diversions from the Upper Truckee River watershed are taken from Lower Echo Lake by the El Dorado Irrigation District and are delivered to the South Fork American River via tunnel. Geology in

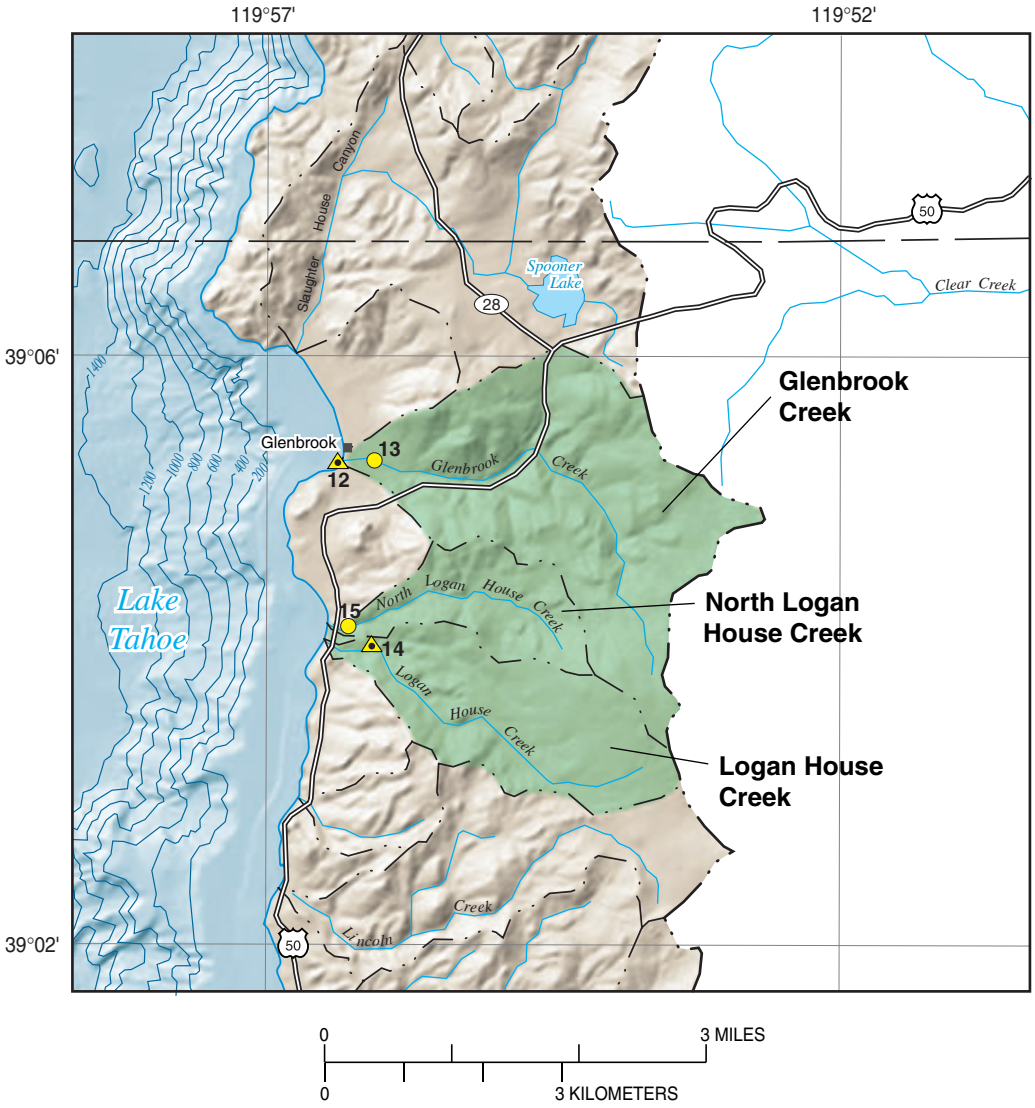

Figure 3. Glenbrook area, Nev., and LTIMP sampling stations.

this area consists mainly of intrusive igneous rocks and unconsolidated sediments with some volcanic rocks (fig. 7).

The Tahoe City to Meeks Bay (west) area has five sampling stations (three primary and two secondary; fig. 6). Features in the west shore area that might affect stream water quality include California Highway 89, concentrated shoreline development, and part of one ski resort. Geology in this area consists mainly of intrusive igneous rocks and unconsolidated sediments with some volcanic rocks and metamorphic rocks (fig. 7).

Climate

For the 1915–98 period of record at the National Weather Service (NWS) station at Tahoe City, Calif., the average maximum air temperature was 13.5°C. The warmest months were June–September, which averaged greater than 20.0°C. The average minimum air temperature was -1.0°C. The coldest months were December–March which were recorded as less than -4.0°C. NWS data is available from Western Region Climate Center internet website at <www.wrcc.dri.edu>.

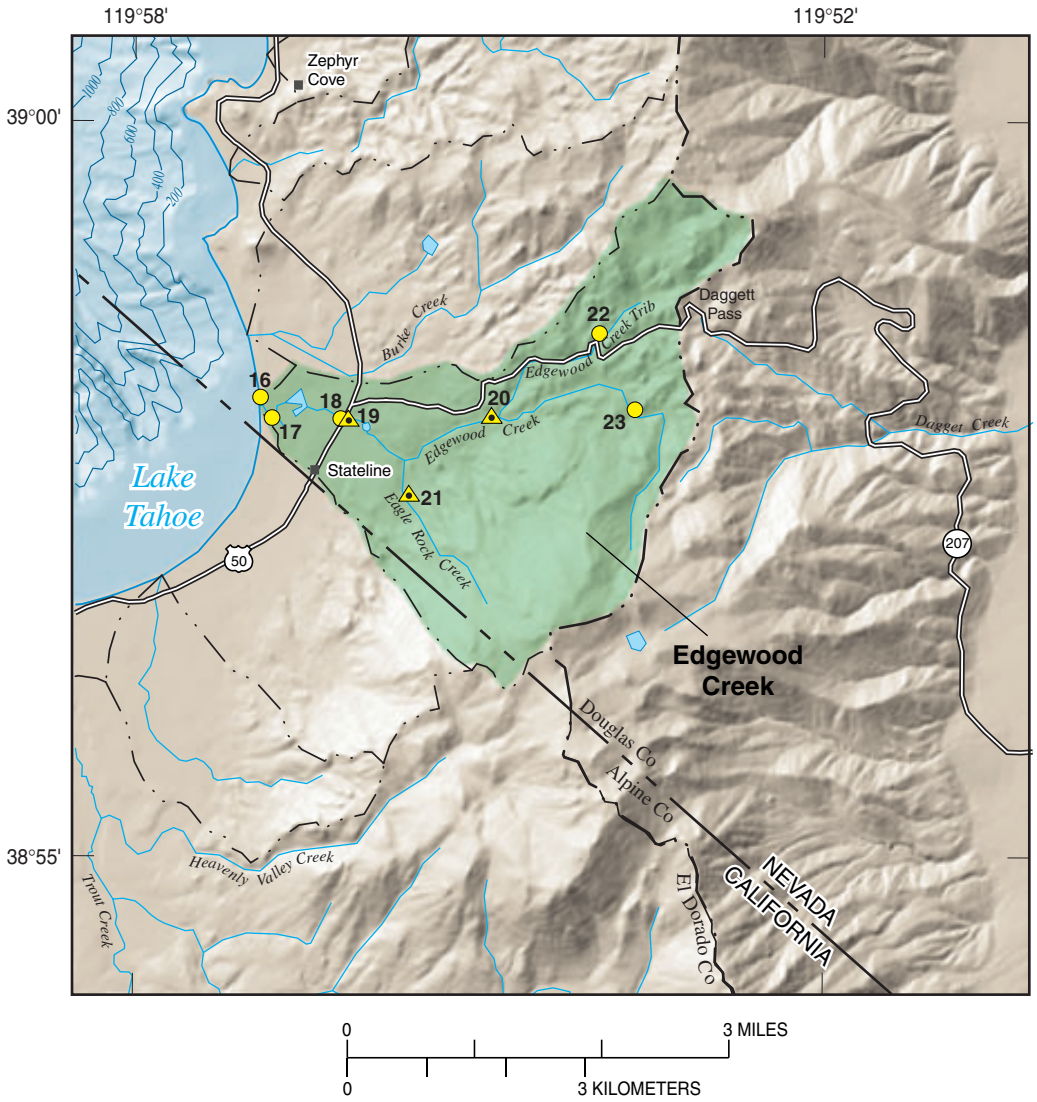

Figure 4. Stateline area, Nev., and LTIMP sampling stations.

Precipitation in the Lake Tahoe Basin ranges from 30 to 40 in/yr on the eastern side to from 70 to 90 in/yr on the western side (Crippen and Pavelka, 1970, fig. 9). Precipitation occurs mostly as snow, mainly from November through March. Precipitation also occurs during rain events, rain-on-snow events, and summer thunderstorms.

Total annual precipitation for the Tahoe City, Calif., station is plotted in figure 8*A* for the period of record 1915–98. Total annual precipitation for the period 1988–98 is highlighted in figure 8*A*. Median total annual precipitation for the 1915–98 period of record was 29.77 in. and for the period 1988–98 was 37.37 in. Total annual precipitation for 1988, 1990–92, and 1994 was below the median; for 1989, 1993, and 1997 was near the median; and for 1995–96 and 1998 was above the median. Years with below median total annual precipitation may be considered drought years.

The years of drought conditions affect the nutrient and suspended-sediment loads in the watersheds as less runoff is generated creating decreased loads. In general,

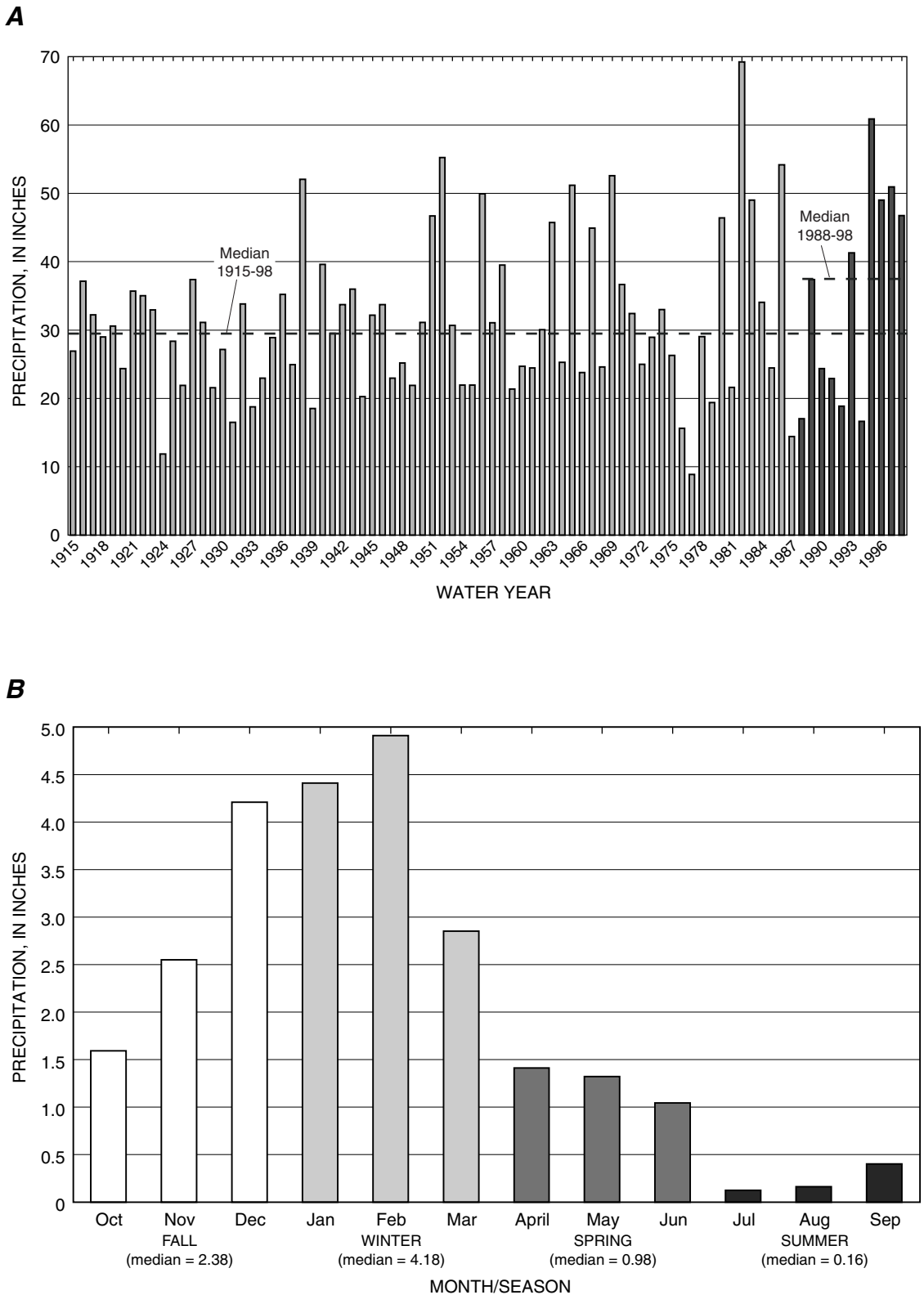

Figure 8. Graphs of: (*A*) total annual precipitation for water years 1915–98, Tahoe City, Calif., and (*B*) Median monthly precipitation for water years 1915–98 and 1988–98 at a national weather station at Tahoe City, Calif.

drought years produce less runoff and loads and above average precipitation years produce more runoff and loads.

The greatest total annual precipitation at Tahoe City, Calif. for the period of record was 69.21 in. in 1982 and the least was 8.82 in. in 1977. For the study period, precipitation ranged from a high of 60.87 in. in 1995 to a low of 16.59 in. in 1994. Median monthly precipitation for the 1915–98 period of record and the 1988–98 study period are plotted in figure 8*B*. Precipitation was highest from November through March and lowest from July through September. Also during the study period, precipitation associated with intense convective summer thunderstorms was less than normal or nearly absent as observed by sampling personnel.

METHODS

Streamflow

Streamflow was measured and continuous streamflow gaging stations were operated according to USGS methods (Buchanan and Somers, 1969; Kennedy, 1983). Periods of missing data for streamflow gaging stations were estimated by comparing records with other gaging stations on the same or nearby watersheds and with temperature and precipitation records.

Streamflow rates at the time of sampling were determined either by making a current-meter measurement or by using a rating-curve estimate; the latter was used if the stage-streamflow relation was available and stable for the particular primary and secondary stations. When samples were collected during periods of changing stage, an average stage was calculated using the gage heights observed or recorded at the beginning and end of the sampling period. The average streamflow then was obtained by looking up the corresponding value on the rating curve.

Annual unit values of runoff were derived from the average annual runoff (acre-feet) divided by the station drainage area (square miles) and reported as acre-feet per square mile. Flood-frequency values were calculated from annual peak streamflow for periods of record for each gaging station using methods described in Thomas and others (1997) and U.S. Interagency Advisory Committee on Water Data (1982).

Watershed-Drainage Information

For this report, drainage areas for sampling stations (table 1) and watershed areas (table 3) were obtained from either the Tahoe Environmental Geographical Information System (TEGIS) project as reported in Cartier and others (1995) or LaRue Smith (U.S. Geological Survey, written commun., 2001). Because of improved geographic technology, these drainage areas supersede previously published values in Water Resources Data Reports (U.S. Geological Survey, 1989–99,published annually). Drainage-basin perimeters and station elevations are in Cartier and others (1995); and channel elevation ranges, maximum watershed elevations, and channel lengths are in Jorgensen and others (1978). Distance from mouth and channel length above station (table 1) were determined from USGS topographic maps.

Water-Quality Data

Field Measurements

Water-quality measurements of water temperature, specific conductance, pH, dissolved oxygen, and dissolved-oxygen saturation were made in the field at the time of sampling. All measurements were made in accordance with USGS methods (U.S. Geological Survey, 1998). Air temperatures were measured at the same time as water-quality parameters.

Nutrients and Suspended Sediments

Samples of nutrient and suspended sediment were collected using USGS methods (Edwards and Glysson, 1988; U.S. Geological Survey, 1998). Discharge-weighted samples were integrated by depth and used the equal-width increment (EWI) method (Edwards and Glysson, 1988) for most of the study. Nutrient samples, collected first, were composited and mixed in a churn splitter. The nutrient samples were then preserved and shipped overnight to TRG laboratories in Tahoe City and Davis, Calif., for analysis using LTIMP procedures described in Hunter and others (1993). Suspended-sediment samples were collected separately, after the nutrient samples, and shipped to the USGS Sediment Laboratory in Salinas, Calif., for analysis using USGS standard guidelines (Guy, 1969).

Nutrient and Suspended-Sediment Load Estimation

Two load calculation computer programs, ESTIMATOR (Cohn and others, 1989) and FLUX (Walker, 1996), were investigated for estimating nutrient and suspended-sediment loads for this study. The use of a third computer program, LOADEST2 (Crawford, 1986), was contemplated, but problems encountered in running this program with the large LTIMP data set precluded its use.

Loads for the 12 miscellaneous stations were not calculated because the samples were collected mainly during high flow (spring snowmelt and storm) events. Daily streamflow measurements also do not exist for these ungaged stations. For load calculations, total nitrogen was obtained by combining total ammonia and organic nitrogen and dissolved nitrite plus nitrate nitrogen. Soluble reactive phosphorus is equivalent dissolved orthophosphate.

ESTIMATOR Program

ESTIMATOR, a log-linear, multiple regression model, relates constituent concentrations to as many as 16 environmental variables or parameters. The program was developed in 1988 to assist USGS personnel in estimating stream-nutrient loads. ESTIMATOR implements the Minimum Variance Unbiased Estimator (MVUE) for the use of estimating fluvial transport of nutrients and sediment (Cohn and others, 1989) and the Adjusted Maximum Likelihood Estimator (AMLE) for the use of data sets containing censored (less than) values (Cohn, 1988 and Cohn and others, 1992). The LTIMP data set contains censored values, particularly those associated with dissolved ammonia.

ESTIMATOR represents concentrations as a function of three factors; flow, time, and a seasonal factor. Outputs include daily and monthly load rates and annual loads for each calendar and water year. To determine a constituent's total load for a given month, the estimated daily mean load rate was multiplied by the number of days in that month. The 95-percent confidence interval was calculated in the program by multiplying the standard error of prediction (SE PRED) by 1.96, which is the value for a 95 percent confidence interval (G. Baier and others, USGS, Reston, Va., written commun., 1993). Load estimates with standard errors (SE) less than 30 percent were accepted, between 30 and 50 percent were marked as questionable and were reviewed and included in the data set if found acceptable after data verification, and greater than 50 percent were not accepted. Monthly load-estimate results are reported in kilograms per month from the ESTIMATOR program. During extreme streamflow events, the program may over-estimate load values (Doug Glysson, U.S. Geological Survey, oral commun., 2000). Estimated nutrient daily and monthly loads used in this report are listed in appendix 2, with estimated SE, estimated SE PRED, and 95-percent confidence intervals.

During lower streamflow events FLUX estimates of nutrient loads for small watersheds exhibited some unusual fluctuations that were not present in the ESTIMATOR results. Thus, estimated values for nutrient loads in this report were taken from ESTIMATOR.

FLUX Program

FLUX, an interactive computer program used to estimate the loadings of nutrients or other water-quality constituents such as suspended sediment, is described in Walker (1996). Data requirements for FLUX include: constituent concentrations, collected on a weekly to monthly frequency for at least a year; date collected; corresponding flow measurements (instantaneous or daily mean values); and a complete flow record (daily mean streamflow) for the period of interest.

Six estimation algorithms are available within FLUX. For calculations in this report the following were used: (1) flow-weighted concentrations (ratio estimate), (2) modified ratio estimate, (3) first order regression, (4) second order regression, and (5) regression applied to individual daily streamflow. FLUX maps the flow versus concentration relation developed from the sample record onto the entire flow record to calculate total mass, streamflow, and associated error statistics. An option included to stratify the data into groups based upon flow was used to improve the fit of the individual models.

FLUX was used for monthly suspended-sediment load estimations, which are listed in appendix 2. Estimates of suspended sediment from FLUX and ESTIMATOR were similar except for overestimates by the latter program for months that included extreme peak events, like the January 1997 flood. Because those ESTIMATOR flood-load results were well above expected reasonable limits for three stations (Black-

wood, Ward, and Logan House Creeks), estimated values for suspended-sediment loads in this report were taken from the FLUX program (app. 2).

Trend Calculations

Calculations for estimating trends in nutrient and suspended-sediment concentrations were made using the Seasonal Kendall test (Helsel and Hirsch, 1992). This is a non-parametric test for a monotonic linear trend that is resistant to outliers and is not dependent on the normality of the data. This test reduces seasonal effects on concentrations when testing trends by comparing the data by season. A Locally Weighted Scatter Plot Smoothing (LOWESS; Helsel and Hirsch, 1992) was used to flow adjust the data by removing the effect of streamflow variations on the concentrations. The Seasonal Kendall test was performed on the flow-adjusted data. Trends detected by the test were considered significant if they had a p-value less than or equal to 0.05; slightly significant with a p-value greater than 0.05 but less than 0.10. Trends were not considered significant with a p-value greater than or equal to 0.10.

RESULTS

Streamflow

Streamflow summary statistics (period of record, average annual mean flows, highest and lowest annual mean flows, annual runoff, unit runoff, highest and lowest daily mean flow, instantaneous peaks, range and median of sampled flow, and number of samples) for the periods of record 1961–98 for the 21 streamflow (20 active and 1 discontinued) gaging stations at the primary and secondary stations are listed in table 4.

Periods of record for the 21 streamflow gaging stations ranged from 4 years (1995–98) at Edgewood Creek at Stateline to 38 years (1961–98) at Trout Creek at Tahoe Valley and Blackwood Creek near Tahoe City. Instantaneous streamflow during the study period for these stations ranged from 0 ft^3/s at five stations during base-flow periods to 5,480 ft^3/s at Upper Truckee River at South Lake Tahoe during a rain-on-snow flood event in January 1997.

Variations in streamflow in the Lake Tahoe Basin are largely due to differences in weather patterns and variations of precipitation amounts and intensity. Smaller variations are due to area and altitude distributions, air and soil temperature, amount of snow on the ground (if present), soil moisture conditions, types of soil and geology, slope and aspect (Jeton, 1999, figs. 6 and 7), type and amount of vegetation coverage (Jeton, 1999, fig. 8) and other natural conditions across the basin.

Streams in the same general area can differ widely in flow, for example, Third and Incline Creeks in the Incline Village area. During the January 1997 flood, the streamflow at Incline Creek near Crystal Bay was 179 ft^3/s, establishing a new record peak, markedly greater than the previous peak of 87 ft^3/s in 1970. The storm peak at Third Creek was only 108 ft^3/s in 1997, well below the previous record peak of 150 ft^3/s set in 1982 (Rowe and others, 1998). Previous studies in the Incline area (Rowe, 1993; Glancy, 1988) also noted that these two creeks are similar in size, in close proximity to each other, but exhibit markedly different runoff characteristics.

The highest mean annual daily mean streamflow was 106 ft^3/s at Upper Truckee River at South Lake Tahoe and the lowest was 0.56 ft^3/s at Logan House Creek near Glenbrook. The highest daily mean streamflow was 3,150 ft^3/s on January 2, 1997, at Upper Truckee River at South Lake Tahoe. The lowest daily mean streamflow of 0 ft^3/s occurred during summer months throughout the period of record at five stations.

Average annual runoff, and unit runoff and unit-runoff ranks for the 10 primary stations for the period of comparison (1988–98) are shown in figures 9 and 10, respectively. Upper Truckee River at South Lake Tahoe had the highest average annual runoff (65,100 acre-ft) and Logan House Creek near Glenbrook had the lowest (340 acre-ft). Blackwood Creek near Tahoe City had the highest unit runoff (2,280 acre-ft/mi^2, rank of 1) and Logan House Creek near Glenbrook had the lowest unit runoff (163 acre-ft/mi^2, rank of 10). Unit runoff on the California or western half of the Lake Tahoe Basin (627–2,280 acre-ft/mi^2) was greater than on the Nevada or eastern half of the basin (163–929 acre-ft mi^2).

Daily mean streamflow for the periods of record for two index stations, Incline Creek near Crystal Bay and Upper Truckee River at South Lake Tahoe, are shown in figures 11*A* and 12*A*. These stations were used to compare a large watershed and a medium-small watershed, a northern and southern watershed, a watershed with greater precipitation and one with less, and one watershed from Nevada and one from California. The annual seasonal pattern is typical of streams in the Lake Tahoe Basin, with most runoff occurring during

Table 4. Streamflow summary statistics through water year 1998 for LTIMP gaging stations in the Lake Tahoe Basin, California and Nevada

[Abbreviation: ft^3/s, cubic feet per second. Symbol: —, not applicable]

Map number	Station name	Number of years of record	Period of record (water years)	Annual mean daily flow (ft^3/s), period of record	Highest annual mean daily flow (ft^3/s) [water year]	Lowest annual mean daily flow (ft^3/s) [water year]	Highest daily mean (ft^3/s) [date]	Lowest daily mean (ft^3/s) [date]	Instantaneous peak (ft^3/s) [date]
Incline Village area (fig. 2)									
5	Third Creek Crystal Bay	27	1970–73 1975 1977–98	8.38	14.1 [1983]	2.92 [1988]	99 [6/19/82]	0.66 [10/13/77]	150 [6/18/82]
8	Incline Creek near Crystal Bay	11	1970–73 1988–98	8.02	15.4 [1995]	2.51 [1992]	112 [1/2/97]	.86 [8/11/92]	179 [1/2/97]
9	Incline Creek at Highway 28	9	1990–98	6.52	10.7 [1995]	1.54 [1992]	85 [1/2/97]	.56 [8/20/92]	143 [1/2/97]
10	Incline Creek above Tyrol Village	9	1990–98	4.65	7.56 [1983]	1.02 [1992]	36 [6/26/95; 1/2/97]	.18 [8//19/92]	52 [6/26/95; 1/2/97]
Glenbrook area (fig. 3)									
12	Glenbrook Creek at Glenbrook	15	1972–75 1988–98	1.75	3.97 [1998]	.36 [1992]	85 [1/2/97]	0 [8/12/94]	144 [1/1/97]
14	Logan House Creek near Glenbrook	15	1984–98	.56	1.36 [1998]	.05 [1992]	8.7 [1/2/97]	0 [7/13/88]	12 [1/2/97; 6/12/98]
Stateline area (fig. 4)									
16	Edgewood Creek at Lake Tahoe	4	1989–92	1.43	1.89 [1990]	1.07 [1992]	16 [8/27/90]	0 [6/22/90]	27 [3/4/91; 10/26/91]
19	Edgewood Creek at Stateline	6	1993–98	4.81	7.15 [1998]	2.17 [1994]	102 [1/2/97]	1.1 [9/28/93	136 [1/2/97]
20	Edgewood Creek at Palisade Dr.	9	1990–98	1.3	2.59 [1997]	.41 [1992]	37 [1/2/97]	.08 [8/10/92	57 [8/14/91]
21	Eagle Rock Creek near Stateline	9	1990–98	.73	1.37 [1997]	.31 [1992]	3.6 [1/2/97]	.19 [9/16/91]	4 [1/2/97]
South Lake Tahoe area (fig. 5)									
26	Trout Creek near Tahoe Valley[1]	38	1961–98	37.4	85.3 [1983]	10.2 [1977]	501 [1/2/97]	2.5 [9/7/88]	535 [2/1/63; 1/2/97]
28	Trout Creek at Pioneer Trail	9	1990–98	26.8	46.9 [1995]	7.71 [1992]	457 [1/2/97]	2 [12/20/90]	525 [1/2/97]

Table 4. Streamflow summary statistics through water year 1998 for LTIMP gaging stations in the Lake Tahoe Basin, California and Nevada—Continued

Map number	Station name	Number of years of record	Period of record (water years)	Annual mean daily flow (ft^3/s), period of record	Highest annual mean daily flow (ft^3/s) [water year]	Lowest annual mean daily flow (ft^3/s) [water year]	Highest daily mean (ft^3/s) [date]	Lowest daily mean (ft^3/s) [date]	Instantaneous peak (ft^3/s) [date]
South Lake Tahoe area (fig. 5)									
29	Trout Creek at U.S. Forest Service Rd. 12N01	9	1990–98	12	19.8 [1995]	4.48 [1992]	130 [6/28/95]	1.9 [12/21/90]	166 [6/27/95]
31	Upper Truckee River at South Lake Tahoe	23	1972–75 1980–98	106	203 [1983]	29.2 [1988]	3,150 [1/2/97]	.7 [8/22/94]	5,480 [1/2/97]
33	Upper Truckee River at Highway 50 above Meyers	9	1990–98	90.3	169 [1995]	26.1 [1994]	2,000 [1/2/97]	1.2 [12/22/90]	5,120 [1/2/97]
34	Upper Truckee River near Meyers	26	1961–86	68.2	128 [1983]	15.7 [1977]	1,840 [12/23/64]	1.5 [8/31/77–9/7/77]	2,550 [2/1/63]
36	Upper Truckee River at South Upper Truckee Rd.	9	1990–98	40.4	72.3 [1995]	14.1 [1994]	1,130 [1/2/97]	.76 [9/1/90]	2,010 [1/2/97]
Tahoe City to Meeks Bay (fig. 6)									
37	General Creek near Meeks Bay	19	1980–98	17.6	34.7 [1982]	4.96 [1988]	600 [1/1/97]	.29 [7/28/94]	797 [1/1/97]
38	Blackwood Creek near Tahoe City	38	1961–98	37.5	73.4 [1982]	8.71 [1977]	2,000 [1/1/97]	.5 [9/24/68]	2,940 [1/1/97]
39	Ward Creek at Highway 89 near Tahoe Pines	26	1973–98	26.9	59 [1983]	5.29 [1977]	1,390 [1/1/97]	0 [8/4/77]	2,530 [11/97]
40	Ward Creek at Stanford Rock Crossing	7	1992–98	28.9	47.5 [1995]	7.69 [1994]	1,300 [1/1/97]	.3 [9/22/94]	2,370 [1/1/97]
41	Ward Creek below Confluence	7	1992–98	18.3	29 [1995]	5.56 [1992]	720 [1/2/97]	0 [8/21/92]	1,220 [1/1/97]

Table 4. Streamflow summary statistics through water year 1998 for LTIMP gaging stations in the Lake Tahoe Basin, California and Nevada—Continued

Map number	Station name	Annual runoff, acre-feet per year				Unit runoff, acre-feet per square mile				Sampled flow, cubic feet per second			
		Period of record	Water years 1988–98	Water years 1991–98	Water years 1992–98	Period of record	Water years 1988–98	Water years 1991–98	Water years 1992–98	Minimum	Maximum	Median	Sample size
Incline Village area (fig. 2)													
5	Third Creek Crystal Bay	6,070	5,590	6,120		1,010	929	1,020	—	0.93	118	7	520
8	Incline Creek near Crystal Bay	5,810	5,910	6,220		868	883	930	—	.56	161	6.6	496
9	Incline Creek at Highway 28	4,730	—	4,730		1,040	—	1,040	—	.55	91	4.7	295
10	Incline Creek above Tyrol Village	3,370	—	3,370		1,180	—	1,180	—	.24	46	3.2	314
Glenbrook area (fig. 3)													
12	Glenbrook Creek at Glenbrook	1,270	1,270	1,290	1,370	310	315	334	—	.01	140	1.3	407
14	Logan House Creek near Glenbrook	403	403	340	381	193	163	182	—	.01	12	.3	367
Stateline area (fig. 4)													
16	Edgewood Creek at Lake Tahoe	1,040	[2]2,660	[3]2,600		158	[2]474	[3]463	—	.01	95	2.4	194
19	Edgewood Creek at Stateline	3,480	[2]2,660	[3]2,600	3,480	620	[2]474	[3]463	620	1.1	133	5.6	216
20	Edgewood Creek at Palisade Dr.	942	—	942	1,080	301	—	301	345	.1	35	1.2	282
21	Eagle Rock Creek near Stateline	526	—	526	565	835	—	835	897	.04	4	.65	230
South Lake Tahoe area (fig. 5)													
26	Trout Creek near Tahoe Valley[1]	27,100	23,000	27,300	—	738	627	744	—	3.2	526	56.5	176
28	Trout Creek at Pioneer Trail	19,400	—	19,400	—	840	—	840	—	4	215	19	274
29	Trout Creek at U.S. Forest Service Rd. 12N01	8,690	—	8,690	—	1,170	—	1,170	—	2.8	160	8.8	196
31	Upper Truckee River at South Lake Tahoe	76,500	65,100	74,200	—	1,420	1,210	1,370	—	.7	5,400	180	203
33	Upper Truckee River at Highway 50 above Meyers	65,400	—	65,400	—	1,660	—	1,660	—	2	1,300	81	264

Table 4. Streamflow summary statistics through water year 1998 for LTIMP gaging stations in the Lake Tahoe Basin, California and Nevada—Continued

Map number	Station name	Annual runoff, acre-feet per year				Unit runoff, acre-feet per square mile				Sampled flow, cubic feet per second			
		Period of record	Water years 1988–98	Water years 1991–98	Water years 1992–98	Period of record	Water years 1988–98	Water years 1991–98	Water years 1992–98	Minimum	Maximum	Median	Sample size
South Lake Tahoe area (fig. 5)													
34	Upper Truckee River near Meyers	49,400				1,490							
36	Upper Truckee River at South Upper Truckee Rd.	29,200	—	29,200	—	2,060	—	2,060	—	1.1	520	45	289
Tahoe City to Meeks Bay (fig. 6)													
37	General Creek near Meeks Bay	12,800	11,400	—		1,730	1,540	—	—	.41	716	40	212
38	Blackwood Creek near Tahoe City	27,200	25,300	—		2,450	2,280	—	—	1.1	2,720	88	235
39	Ward Creek at Highway 89 near Tahoe Pines	19,500	18,000	—	22,100	2,000	1,850	—	2,270	.22	1,990	67	235
40	Ward Creek at Stanford Rock Crossing	21,000	—	—	21,000	2,340	—	—	2,340	.38	441	48	157
41	Ward Creek below Confluence	13,200	—	—	13,200	2,660	—	—	2,660	.01	288	31	145

[1] Gaging station location for Trout Creek at South Lake Tahoe sampling station.
[2] 1989–98 combined runoffs used as estimate for 1988–98 period.
[3] Runoff combined from Edgewood Creek at Lake Tahoe and at Stateline for 1991–98 comparison period.

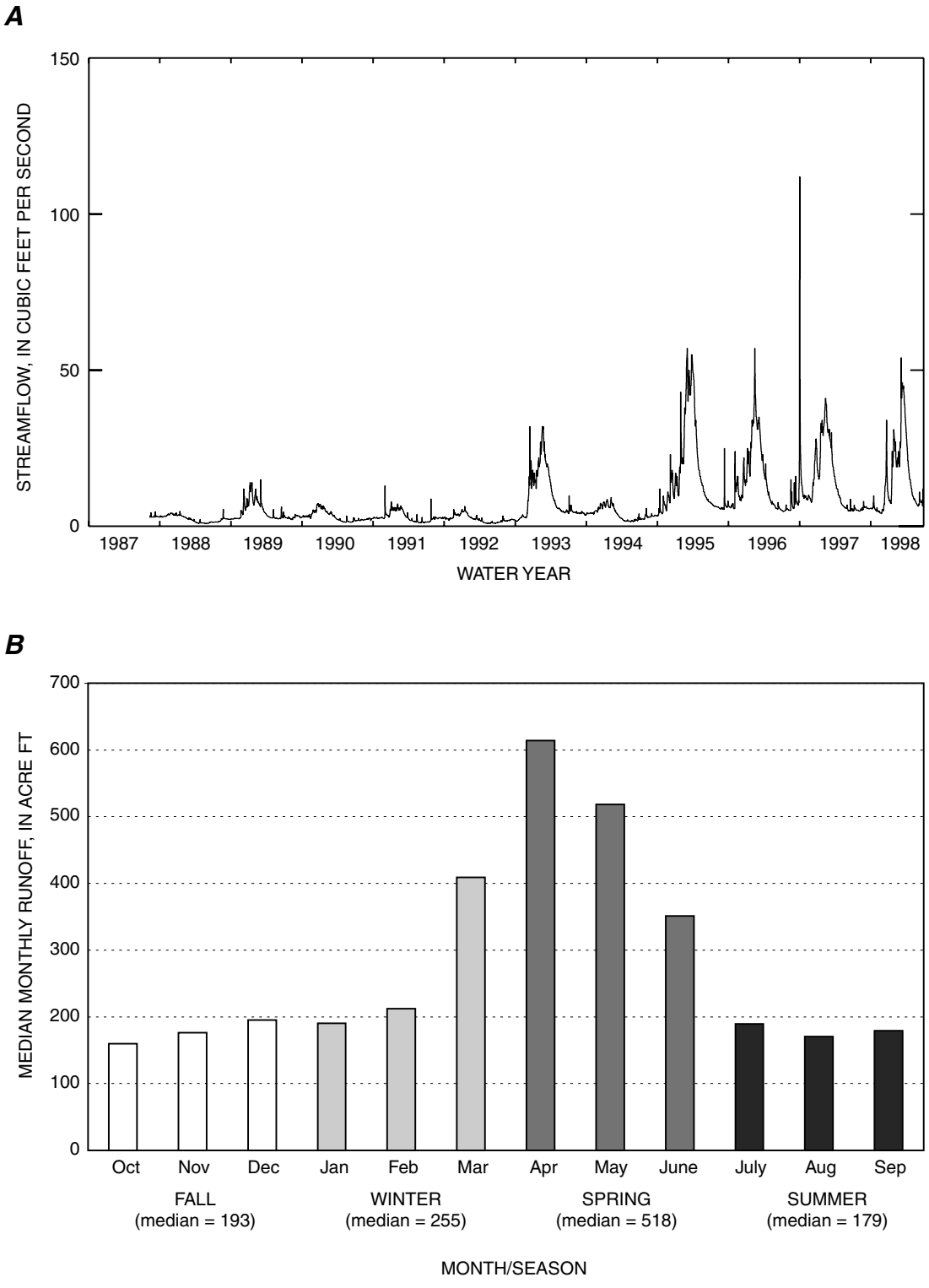

Figure 11. Plots for Incline Creek near Crystal Bay, a representative LTIMP gage station, for water years 1988–98: (*A*) Annual discharge, and (*B*) Median monthly and seasonal runoff.

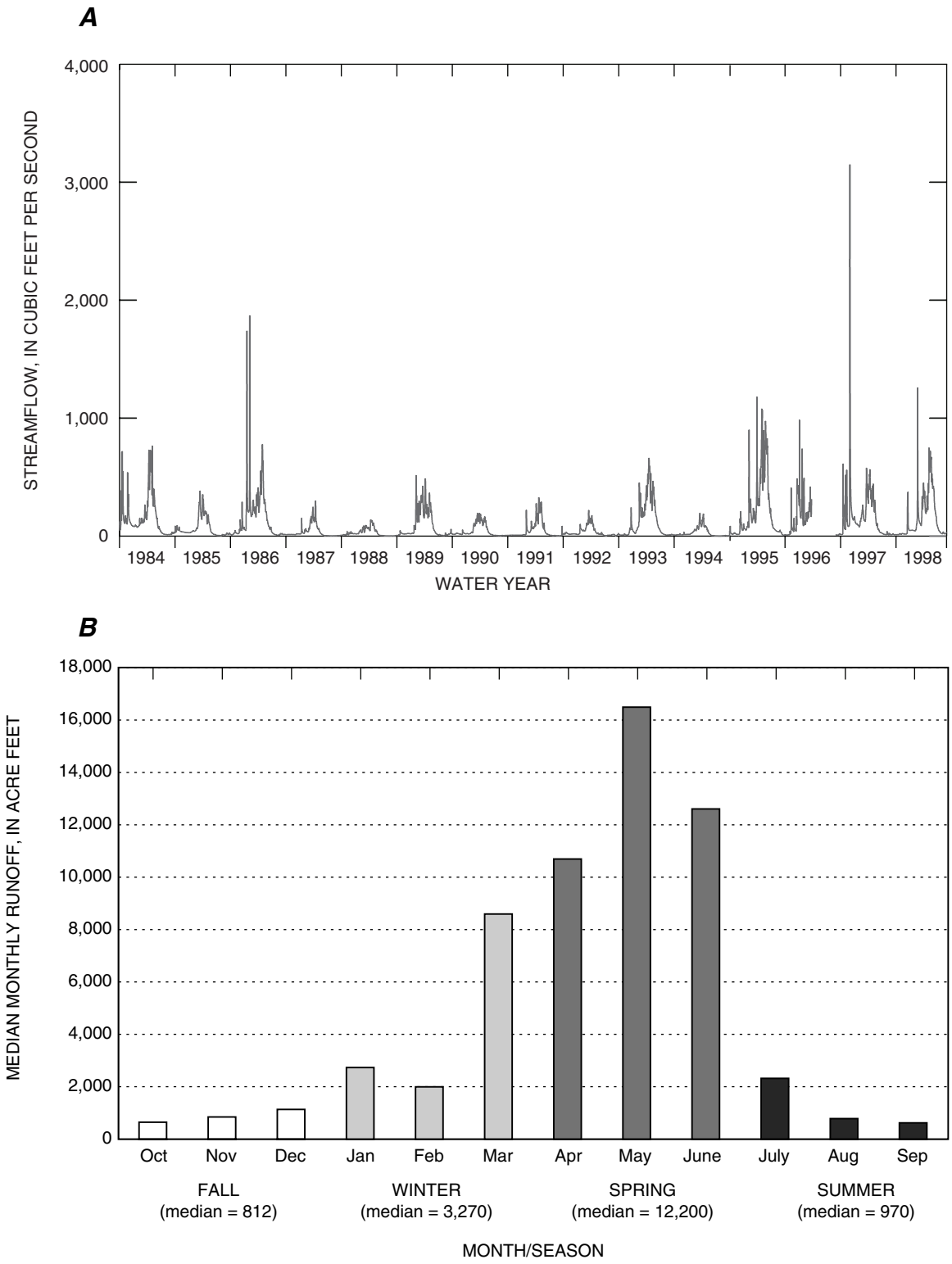

Figure 12. Plots for Upper Truckee River at South Lake Tahoe, a representative LTIMP gage station: (*A*) Annual discharge for water years 1984–98, and (*B*) Median monthly and seasonal runoff for water years 1988–98.

the spring snowmelt period (April, May, and June). Other events include rainstorms in the fall period (October, November, and December), rain-on-snow storms in the winter period (January, February, and March), and convective thunderstorms in the summer period (July, August, and September). Median monthly runoff values are plotted in figures 11*B* and 12*B*. These plots show that more streamflow occurs in the spring period and less in the summer and fall periods.

A flood-frequency summary for 20 streamflow gaging stations and 6 historical (discontinued) streamflow gaging stations in the monitored watersheds is listed in table 5. The 50-year and 100-year peak streamflows and maximum recorded peak streamflows through water year 1998 (Glen W. Hess, U.S. Geological Survey, written commun., 2000) also are listed in table 5.

Water-Quality Data

Field Measurements

Field measurements were made during sample collection. Summary statistics (minimums, maximums, medians, and number of samples) are listed in tables 6, 7, 8 and 9 for 10 primary, 10 secondary, and 14 miscellaneous water-quality stations.

Water Temperature

Water temperatures (table 6) ranged from 0°C during winter periods at many locations to 23.0°C during summer periods at two lower elevation stations, Edgewood Creek at Lake Tahoe and Ward Creek at Highway 89 near Tahoe City. For all stations, the highest median temperature was 14.0°C at Tributary to Edgewood Creek and the lowest was 2.5°C at Ward Creek below confluence. For primary and secondary stations, the highest median temperature was 6.0°C at many locations and the lowest was 2.5°C at Ward Creek below confluence. Water temperatures typically increased slightly downstream.

Specific Conductance

Specific conductance (table 7) ranged from 8 microsiemens per centimeter (µS/cm) at General Creek near Meeks Bay during snowmelt in the spring to 900 µS/cm at Glenbrook Creek at Glenbrook during low summer streamflow. For all stations, the highest median specific conductance was 466 µS/cm at Glenbrook Creek at old highway and the lowest was 21 µS/cm at General Creek near Meeks Bay. For primary and secondary stations, the highest median specific conductance was 455 µS/cm at Glenbrook Creek at Glenbrook and the lowest was 21 µS/cm at General Creek near Meeks Bay. Specific conductance typically increases downstream, as noted for Incline Creek in Rowe (1999). In general, specific conductance is higher on the eastern side of the basin.

pH

pH (table 8) ranged from 6.6 during spring snowmelt at Trout Creek at Pioneer Trail to 10.6 during summer low-flow periods at Edgewood Creek at Lake Tahoe. For all stations, the highest median pH was 8.8 at Edgewood Creek at Lake Tahoe and the lowest was 7.2 at General Creek near Meeks Bay. For primary and secondary stations, the highest median pH was 8.2 at Logan House Creek near Glenbrook and the lowest was 7.2 at General Creek near Meeks Bay. In general, pH appears to be higher on the eastern side of the basin and does not seem to vary in a downstream direction.

Dissolved Oxygen

Dissolved oxygen (DO; table 9) ranged from 5.2 milligrams per liter (mg/L) at Edgewood Creek at Lake Tahoe to 12.6 mg/L at Logan House Creek near Glenbrook and Incline Creek near Crystal Bay. For all stations, the highest median DO was 10.2 mg/L at Ward Creek at Highway 89 near Tahoe City and the lowest was 8.3 mg/L at Edgewood Creek Tributary near Daggett Pass. For primary and secondary stations, the highest median DO was 10.2 mg/L at Ward Creek at Highway 89 and the lowest was 9.2 mg/L at Glenbrook Creek at Glenbrook.

Dissolved-oxygen concentration was near saturation (100 percent) for most stations. Dissolved-oxygen saturation ranged from 70 to 157 percent; both occurred at Edgewood Creek at Lake Tahoe. For all stations, the highest median saturation was 106 percent at Edgewood Creek at Lake Tahoe and the lowest was 92 percent at Edgewood Creek Tributary near Daggett Pass. For primary and secondary stations, the highest median saturation was 103 percent at Upper Truckee River at South Lake Tahoe and the lowest was 96 percent at Glenbrook Creek at Glenbrook.

Table 5. Flood-frequency information for LTIMP and USGS gaging stations in the monitored watersheds in the Lake Tahoe Basin through water year 1998, California and Nevada

[Abbreviations: ft^3/s, cubic feet per second; ND, not determined. Note: Data from Glen W. Hess, U.S. Geological Survey, written commun., 2000]

USGS station number	USGS station name	Period of record, water years	50-year peak streamflow (ft^3/s) [1]	100-year peak streamflow (ft^3/s)[1]	Maximum peak streamflow of record	
					Date	Streamflow (ft^3/s)
10336688	First Creek (at Highway 28) near Crystal Bay, Nev.	1970–74	129	182	September 26, 1973	22
10336690	Second Creek at Lakeshore Dr. near Crystal Bay, Nev.	1970–74	164	225	May 18, 1970	16
10336694	Wood Creek at mouth (at Lakeshore Dr.) near Crystal Bay, Nev.	1970–74	216	302	May 18, 1970	15
10336698	Third Creek (at Lakeshore Dr.) near Crystal Bay, Nev.	1970–73, 1975, 1978–98	625	907	June 18, 1982	150
10336700	Incline Creek (above Lakeshore Dr.) near Crystal Bay, Nev.	1970–75, 1988–98	496	652	January 2, 1997	179
103366995	Incline Creek at Highway 28 at Incline Village, Nev.	1990–98	333	470	January 2, 1997	143
103366993	Incline Creek above Tyrol Village near Incline Village, Nev.	1991–98	126	157	June 26,1995 and January 2, 1997	52
10336730	Glenbrook Creek (near mouth) at Glenbrook, Nev.	1972–75, 1988–98	158	243	January 1, 1997	144
10336740	Logan House Creek near Glenbrook, Nev.	1984–98	24	31	January 2, 1997 and June 12, 1998	12
10336765	Edgewood Creek at Lake Tahoe near Stateline, Nev.	1989–92	[2]ND	[2]ND	March 4, 1991 and October 26, 1991	27
10336760	Edgewood Creek (at Highway 50) at Stateline, Nev.	1993–98	[2]ND	[2]ND	January 2, 1997	136
103367585	Edgewood Creek at Palisade Dr. near Kingsbury, Nev.	1991–98	[3]149	[3]199	August 14, 1991	57
103367592	Eagle Rock Creek near Stateline, Nev.	1991–98	[3]68	[3]94	January 2, 1997	4
10336790	Trout Creek (at Highway 50) at South Lake Tahoe, Calif.	1972–74	773	966	May 31, 1973	190
10336780	Trout Creek (at Martin Ave.) near Tahoe Valley, Calif.	1961–98	716	894	February 1, 1963 and January 2, 1997	535
10336775	Trout Creek at Pioneer Trial near South Lake Tahoe, Calif.	1991–98	505	630	January 2, 1997	525
10336770	Trout Creek at U.S. Forest Service Road 12N01 near Meyers, Calif.	1991–98	365	450	June 27, 1995	166
10336610	Upper Truckee River (at Highway 50) at South Lake Tahoe, Calif.	1972–74, 1978, 1980–98	[4]4,390	5,700	January 2, 1997	5,480

Table 5. Flood-frequency information for LTIMP and USGS gaging stations in the monitored watersheds in the Lake Tahoe Basin through water year 1998, California and Nevada—Continued

USGS station number	USGS station name	Period of record, water years	50-year peak streamflow (ft^3/s)[1]	100-year peak streamflow (ft^3/s)[1]	Maximum peak streamflow of record	
					Date	Streamflow (ft^3/s)
103366092	Upper Truckee River at Highway 50 above Meyers, Calif.	1991–98	3,310	4,060	January 2, 1997	5,120
10336600	Upper Truckee River near Meyers, Calif.	1961–86	2,900	3,540	February 1, 1963	2,550
10336580	Upper Truckee River at South Upper Truckee Road near Meyers, Calif.	1991–98	[5]1,460	1,790	January 2, 1997	2,010
10336645	General Creek (at Highway 89) near Meeks Bay, Calif.	1980–98	1,230	1,560	January 1, 1997	797
10336660	Blackwood Creek (at Highway 89) near Tahoe City, Calif.	1961–98	3,500	4780	January 1, 1997	2,940
10336674	Ward Creek below confluence near Tahoe City, Calif.	1992–98	1,390	1,890	January 1, 1997	1,220
10336675	Ward Creek at Stanford Rock Trail Crossing near Tahoe City, Calif.	1992–98	2,240	3,030	January 1, 1997	2,370
10336676	Ward Creek at State Highway 89 near Tahoe Pines, Calif.	1973–98	2,650	3,620	January 1, 1997	2,530

[1] Determined from U.S. Interagency Advisory Committee on Water Data (1982) guidelines except where noted. The 100-year peak streamflow is theoretical and statistically has a 1-percent chance of occurring in any given year. Likewise, the 50-year peak streamflow is theoretical and statistically has a 2-percent chance of occurring in any given year.

[2] Affected by regulation; value not determined (ND).

[3] Estimated by regression methods of Thomas and others (1997).

[4] Determined from U.S. Interagency Advisory Committee on Water Data (1982) guidelines based on historical flood designation.

[5] Estimated by methods of Thomas and others (1997) and a nearby gaging station on the same stream.

Table 6. Water temperature data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada

[Abbreviation: °C, degrees Celsius. Symbol: —, not applicable]

Map number	Station name	Period of record	Sample size	Water temperature, °C		
				Minimum	Maximum	Median
	Incline Village area (fig. 2)					
1	First Creek (at Highway 28) near Crystal Bay, Nev.	1991–98	73	1.0	13.5	6.5
2	Second Creek at Lakeshore Dr. near Crystal Bay, Nev.	1991–98	69	.5	15.0	7.5
3	Wood Creek near mouth (at Lakeshore Dr.) near Crystal Bay, Nev.	1991–98	71	.5	14.0	7.0
4	Wood Creek above Jennifer St. near Incline Village, Nev.	1991–98	62	.5	12.5	7.0
5	Third Creek (at Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	504	0	22.0	6.0
6	Third Creek at Village Blvd. at Incline Village, Nev.	1991–98	70	2.0	15.5	6.5
7	Third Creek below unnamed tributary near Incline Village, Nev.	1991–98	65	1.5	14.0	5.5
8	Incline Creek (above Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	478	0	18.5	6.0
9	Incline Creek at Highway 28 at Incline Village, Nev.	1990–98	289	0	14.5	6.0
10	Incline Creek above Tyrol Village near Incline Village, Nev.	1990–98	307	0	18.0	5.0
11	Incline Creek Tributary at County Club Dr. near Incline Village, Nev.	1991–98	85	1.5	14.5	8.5
	Glenbrook area (fig. 3)					
12	Glenbrook Creek (near mouth) at Glenbrook, Nev.	1972–75 1988–98	398	0	17.0	6.0
13	Glenbrook Creek at Old Highway near Glenbrook, Nev.	1991–88	68	1.0	16.5	8.0
14	Logan House Creek near Glenbrook, Nev.	1984–98	344	0	12.0	4.0
15	North Logan House Creek above Highway 50 near Glenbrook, Nev.	1991–98	71	.5	12.0	6.5
	Stateline area (fig. 4)					
16	Edgewood Creek at Lake Tahoe near Stateline, Nev.	1989–98	190	.5	23.0	12.0
17	Edgewood Creek Tributary above Clubhouse near Stateline, Nev.	1995–98	9	5.5	18.0	14.0
18	Culvert into Edgewood Creek above Highway 50 at Stateline, Nev.	1998	10	3.5	18.5	9.5
19	Edgewood Creek (at Highway 50) at Stateline, Nev.	1992–98	210	.5	14	6.0
20	Edgewood Creek at Palisade Dr. near Kingsbury, Nev.	1990–98	273	.5	13.0	5.5
21	Eagle Rock Creek near Stateline, Nev.	1990–98	220	.5	11.0	5.0

Table 6. Water temperature data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada—Continued

Map number	Station name	Period of record	Sample size	Water temperature, °C		
				Minimum	Maximum	Median
	Stateline area (fig. 4)					
22	Edgewood Creek Tributary near Daggett Pass, Nev.	1990–98	47	.5	13.0	6.0
23	Edgewood Creek below South Benjamin Dr. near Daggett Pass, Nev.	1990–98	77	1.5	13.5	7.5
	South Lake Tahoe area (fig. 5)					
24	Trout Creek near mouth — east off Bellevue/El Dorado Ave.	1998	recorder	0	17.5	—
27	Cold Creek at mouth near South Lake Tahoe, Calif.	1998	recorder	0	14.0	—
28	Trout Creek at Pioneer Trail near South Lake Tahoe, Calif.	1990–98	270 + recorder	0	19.5	6.0
29	Trout Creek at U.S. Forest Service Rd. 12N01 near Meyers, Calif.	1990–98	191 + recorder	0	12.5	6.0
30	Upper Truckee River near mouth off Venice Dr. near South Lake Tahoe, Calif.	1998	recorder	0	21.5	—
31	Upper Truckee River (at Highway 50) at South. Lake Tahoe, Calif.	1993–98	192	0	22.0	6.0
32	Upper Truckee River at Highway 50 below Meyers, Calif.	1998	recorder	0	22.0	—
33	Upper Truckee River at Highway 50 above Meyers, Calif.	1990–98	258	0	20.0	6.0
35	Grass Lake Creek at Grass Lake Rd. near Meyers, Calif.	1998	recorder	0	14.5	—
36	Upper Truckee River at South Upper Truckee Rd. near Meyers, Calif.	1990–98	280	0	18.0	4.5
	Tahoe City to Meeks Bay area (fig. 6)					
37	General Creek (at Highway 89) near Meeks Bay, Calif.	1993–98	214	0	19.0	3.5
38	Blackwood Creek (at Highway 89) near Tahoe City, Calif.	1993–98	234	0	22.0	4.0
39	Ward Creek at Highway 89 near Tahoe Pines, Calif.	1993–98	235	0	23.0	3.5
40	Ward Creek at Stanford Rock Trail crossing near Tahoe City, Calif.	1992–98	158	0	22.0	4.5
41	Ward Creek below confluence near Tahoe City, Calif.	1992–98	140	0	18.5	2.5

Table 7. Specific conductance data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada

[Abbreviation: µS/cm, microsiemens per centimeter]

Map number	Station name	Period of record	Sample size	Specific conductance, µS/cm		
				Minimum	Maximum	Median
	Incline Village area (fig. 2)					
1	First Creek (at Highway 28) near Crystal Bay, Nev.	1991–98	73	41	104	66
2	Second Creek at Lakeshore Dr. near Crystal Bay, Nev.	1991–98	69	28	132	58
3	Wood Creek near mouth (at Lakeshore Dr.) near Crystal Bay, Nev.	1991–98	71	33	94	54
4	Wood Creek above Jennifer St. near Incline Village, Nev.	1991–98	62	32	69	47
5	Third Creek (at Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	486	27	167	72
6	Third Creek at Village Blvd. at Incline Village, Nev.	1991–98	69	26	76	42
7	Third Creek below unnamed tributary near Incline Village, Nev.	1991–98	65	23	57	39
8	Incline Creek (above Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	475	38	166	77
9	Incline Creek at Highway 28 at Incline Village, Nev.	1990–98	272	25	121	51
10	Incline Creek above Tyrol Village near Incline Village, Nev.	1990–98	283	19	54	35
11	Incline Creek Tributary at County Club Dr. near Incline Village, Nev.	1991–98	85	103	210	114
	Glenbrook area (fig. 3)					
12	Glenbrook Creek (near mouth) at Glenbrook, Nev.	1972–75 1988–98	372	149	900	455
13	Glenbrook Creek at Old Highway near Glenbrook, Nev.	1991–88	68	137	833	466
14	Logan House Creek near Glenbrook, Nev.	1984–98	330	60	163	128
15	North Logan House Creek above Highway 50 near Glenbrook, Nev.	1991–98	70	59	111	86.5
	Stateline area (fig. 4)					
16	Edgewood Creek at Lake Tahoe near Stateline, Nev.	1989–98	187	80	268	121
17	Edgewood Creek Tributary above Clubhouse near Stateline, Nev.	1995–98	9	94	302	167

Table 7. Specific conductance data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada—Continued

Map number	Station name	Period of record	Sample size	Specific conductance, µS/cm		
				Minimum	Maximum	Median
	Stateline area (fig. 4)					
18	Culvert into Edgewood Creek above Highway 50 at Stateline, Nev.	1995–98	10	56	786	280
19	Edgewood Creek (at Highway 50) at Stateline, Nev.	1992–98	198	84	245	129
20	Edgewood Creek at Palisade Dr. near Kingsbury, Nev.	1990–98	256	69	498	150
21	Eagle Rock Creek near Stateline, Nev.	1990–98	202	28	61	52
22	Edgewood Creek Tributary near Daggett Pass, Nev.	1990–98	47	149	335	199
23	Edgewood Creek below South Benjamin Dr. near Daggett Pass, Nev.	1990–98	77	67	495	116
	South Lake Tahoe area (fig. 5)					
25	Trout Creek (at Highway 50) at South Lake Tahoe, Calif.	1993–98	172	22	71	44
28	Trout Creek at Pioneer Trail near South Lake Tahoe, Calif.	1990–98	245	18	68	45
29	Trout Creek at U.S. Forest Service Rd. 12N01 near Meyers, Calif.	1990–98	178	16	63	40
31	Upper Truckee River (at Highway 50) at South Lake Tahoe, Calif.	1993–98	188	17	135	46.5
33	Upper Truckee River at Highway 50 above Meyers, Calif.	1990–98	245	17	120	47
36	Upper Truckee River at South Upper Truckee Rd. near Meyers, Calif.	1990–98	262	13	75	24
	Tahoe City to Meeks Bay area (fig. 6)					
37	General Creek (at Highway 89) near Meeks Bay, Calif.	1993–98	212	8	70	21
38	Blackwood Creek (at Highway 89) near Tahoe City, Calif.	1993–98	235	21	92	40
39	Ward Creek at Highway 89 near Tahoe Pines, Calif.	1993–98	233	21	95	40
40	Ward Creek at Stanford Rock Trail crossing near Tahoe City, Calif.	1992–98	155	27	108	39
41	Ward Creek below confluence near Tahoe City, Calif.	1992–98	143	22	57	32

Table 8. pH data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada

[Symbol: —, not applicable]

Map number	Station name	Period of record	Sample size	pH, standard units		
				Minimum	Maximum	Median
	Incline Village area (fig. 2)					
1	First Creek (at Highway 28) near Crystal Bay, Nev.	1991–98	29	7.4	8.5	8.1
2	Second Creek at Lakeshore Dr. near Crystal Bay, Nev.	1991–98	29	7.4	8.4	8.1
3	Wood Creek near mouth (at Lakeshore Dr.) near Crystal Bay, Nev.	1991–98	29	7.6	8.5	8.0
4	Wood Creek above Jennifer St. near Incline Village, Nev.	1991–98	27	7.6	8.4	8.0
5	Third Creek (at Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	172	7.1	8.7	7.9
6	Third Creek at Village Blvd. at Incline Village, Nev.	1991–98	31	7.1	8.4	7.8
7	Third Creek below unnamed tributary near Incline Village, Nev.	1991–98	29	7.2	8.7	7.9
8	Incline Creek (above Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	165	7.0	8.6	7.9
9	Incline Creek at Highway 28 at Incline Village, Nev.	1990–98	97	6.9	8.5	7.8
10	Incline Creek above Tyrol Village near Incline Village, Nev.	1990–98	95	7.1	8.6	7.8
11	Incline Creek Tributary at County Club Dr. near Incline Village, Nev.	1991–98	34	7.5	8.3	8.0
	Glenbrook area (fig. 3)					
12	Glenbrook Creek (near mouth) at Glenbrook, Nev.	1972–75 1988–98	135	6.9	9.1	8.0
13	Glenbrook Creek at Old Highway near Glenbrook, Nev.	1991–88	32	7.3	8.5	8.2
14	Logan House Creek near Glenbrook, Nev.	1984–98	124	7.3	8.9	8.2
15	North Logan House Creek above Highway 50 near Glenbrook, Nev.	1991–98	32	7.5	8.9	8.2
	Stateline area (fig. 4)					
16	Edgewood Creek at Lake Tahoe near Stateline, Nev.	1989–98	87	7.3	10.6	8.8
17	Edgewood Creek Tributary above Clubhouse near Stateline, Nev.	1995–98	1	—	—	8.1
18	Culvert into Edgewood Creek above Highway 50 at Stateline, Nev.	1995–98	3	7.8	8.2	8.0

Table 8. pH data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada—Continued

Map number	Station name	Period of record	Sample size	pH, standard units		
				Minimum	Maximum	Median
	Stateline area (fig. 4)					
19	Edgewood Creek (at Highway 50) at Stateline, Nev.	1992–98	47	6.7	8.6	7.9
20	Edgewood Creek at Palisade Dr. near Kingsbury, Nev.	1990–98	88	7.1	8.5	8.0
21	Eagle Rock Creek near Stateline, Nev.	1990–98	78	7.0	8.7	7.9
22	Edgewood Creek Tributary near Daggett Pass, Nev.	1990–98	16	7.2	8.8	7.7
23	Edgewood Creek below South Benjamin Dr. near Daggett Pass, Nev.	1990–98	33	7.4	9.3	7.9
	South Lake Tahoe area (fig. 5)					
25	Trout Creek near mouth — east off Bellevue/El Dorado Ave.	1993–98	48	7.0	8.4	7.5
28	Trout Creek (at Highway 50) at South Lake Tahoe, Calif.	1990–98	94	6.6	8.4	7.8
29	Trout Creek (at Martin Ave.) near Tahoe Valley, Calif.	1990–98	75	6.8	8.7	7.9
31	Cold Creek at mouth near South Lake Tahoe, Calif.	1993–98	51	7.0	8.4	7.5
33	Trout Creek at Pioneer Trail near South Lake Tahoe, Calif.	1990–98	97	7.0	9.3	7.7
36	Trout Creek at U.S. Forest Service Rd. 12N01 near Meyers, Calif.	1990–98	103	7.0	8.8	7.8
	Tahoe City to Meeks Bay area (fig. 6)					
37	Upper Truckee River (at Highway 50) at South Lake Tahoe, Calif.	1993–98	13	6.7	7.8	7.2
38	Upper Truckee River at Highway 50 below Meyers, Calif.	1993–98	13	7.0	8.0	7.4
39	Upper Truckee River at Highway 50 above Meyers, Calif.	1993–98	12	7.3	7.9	7.5
40	Grass Lake Creek at Grass Lake Rd. near Meyers, Calif.	1992–98	1	—	—	8.1
41	Upper Truckee River at South Upper Truckee Rd. near Meyers, Calif.	1992–98	0	—	—	—

Table 9. Dissolved oxygen data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada

[Abbreviation: mg/L, milligrams per liter. Symbol: —, not applicable]

Map number	Station name	Period of record	Sample size	Dissolved oxygen (mg/L) [saturation, percent]		
				Minimum	Maximum	Median
	Incline Village area (fig. 2)					
1	First Creek (at Highway 28) near Crystal Bay, Nev.	1991–98	17 17	8.7 [86]	10.7 [104]	9.6 [100]
2	Second Creek at Lakeshore Dr. near Crystal Bay, Nev.	1991–98	17 17	8.0 [95]	11.1 [106]	9.6 [100]
3	Wood Creek near mouth (at Lakeshore Dr.) near Crystal Bay, Nev.	1991–98	17 17	8.3 [98]	11.4 [104]	9.7 [100]
4	Wood Creek above Jennifer St. near Incline Village, Nev.	1991–98	12 12	8.1 [98]	10.9 [114]	9.4 [99.5]
5	Third Creek (at Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	124 124	7.2 [91]	11.9 [110]	9.6 [99]
6	Third Creek at Village Blvd. at Incline Village, Nev.	1991–98	17 17	8.2 [95]	10.8 [124]	9.6 [100]
7	Third Creek below unnamed tributary near Incline Village, Nev.	1991–98	16 16	8.0 [97]	11.1 [110]	9.6 [100]
8	Incline Creek (above Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	119 119	7.3 [92]	12.6 [116]	9.7 [100]
9	Incline Creek at Highway 28 at Incline Village, Nev.	1990–98	71 71	7.8 [92]	11.8 [108]	9.7 [99]
10	Incline Creek above Tyrol Village near Incline Village, Nev.	1990–98	67 66	7.2 [87]	12.1 [115]	9.8 [100]
11	Incline Creek Tributary at County Club Dr. near Incline Village, Nev.	1991–98	24 24	7.9 [92]	10.4 [113]	9.2 [99]
	Glenwood area (fig. 3)					
12	Glenbrook Creek (near mouth) at Glenbrook, Nev.	1988–98	107 107	6.0 [71]	12.2 [118]	9.2 [96]

Table 9. Dissolved oxygen data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada—Continued

Map number	Station name	Period of record	Sample size	Dissolved oxygen (mg/L) [saturation percent]		
				Minimum	Maximum	Median
	Glenwood area (fig. 3)					
13	Glenbrook Creek at Old Highway near Glenbrook, Nev.	1991–88	21 21	7.9 [94]	11.2 [108]	9.3 [100]
14	Logan House Creek near Glenbrook, Nev.	1984–98	96 96	7.6 [87]	12.6 [112]	9.9 [99]
15	North Logan House Creek above Highway 50 near Glenbrook, Nev.	1991–98	14 14	8.7 [94]	11.0 [106]	9.4 [100]
	Stateline area (fig. 4)					
16	Edgewood Creek at Lake Tahoe near Stateline, Nev.	1989–98	62 61	5.2 [70]	11.5 [157]	9.7 [106]
17	Edgewood Creek Tributary above Clubhouse near Stateline, Nev.	1995–98	1 1	— —	— —	8.1 [83]
18	Culvert into Edgewood Creek above Highway 50 at Stateline, Nev.	1995–98	0	—	—	—
19	Edgewood Creek (at Highway 50) at Stateline, Nev.	1992–98	34 34	8.2 [92]	11.0 [119]	9.6 [100]
20	Edgewood Creek at Palisade Dr. near Kingsbury, Nev.	1990–98	65 65	7.9 [93]	11.5 [114]	9.7 [98]
21	Eagle Rock Creek near Stateline, Nev.	1990–98	44 44	8.8 [88]	11.0 [114]	9.8 [98]
22	Edgewood Creek Tributary near Daggett Pass, Nev.	1990–98	7 7	7.5 [79]	10.2 [103]	8.3 [92]
23	Edgewood Creek below South Benjamin Dr. near Daggett Pass, Nev.	1990–98	14 14	7.9 [88]	10.5 [106]	8.8 [96]
	South Lake Tahoe area (fig. 5)					
25	Trout Creek near mouth — east off Bellevue/El Dorado Ave.	1993–98	34 34	8.4 [92]	11.4 [114]	9.8 [99]
28	Trout Creek (at Highway 50) at South Lake Tahoe, Calif.	1990–98	68 68	6.8 [91]	12.1 [116]	9.5 [99]

Table 9. Dissolved oxygen data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada—Continued

Map number	Station name	Period of record	Sample size	Dissolved oxygen (mg/L) [saturation percent]		
				Minimum	Maximum	Median
	South Lake Tahoe area (fig. 5)					
29	Trout Creek (at Martin Ave.) near Tahoe Valley, Calif.	1990–98	47 47	8.0 [90]	11.5 [109]	9.3 [100]
31	Cold Creek at mouth near South Lake Tahoe, Calif.	1993–98	42 42	6.8 [91]	11.3 [126]	9.6 [103]
33	Trout Creek at Pioneer Trail near South Lake Tahoe, Calif.	1990–98	73 73	6.7 [86]	11.6 [114]	9.8 [101]
36	Trout Creek at U.S. Forest Service Rd. 12N01 near Meyers, Calif.	1990–98	74 73	7.3 [86]	12.4 [114]	10.0 [101]
	Tahoe City to Meeks Bay area (fig. 6)					
37	General Creek (at Highway 89) near Meeks Bay, Calif.	1993–98	40 40	6.6 [88]	11.2 [104]	9.8 [98]
38	Blackwood Creek (at Highway 89) near Tahoe City, Calif.	1993–98	41 41	6.9 [93]	11.4 [103]	9.7 [99]
39	Ward Creek at Highway 89 near Tahoe Pines, Calif.	1993–98	40 40	7.2 [88]	11.6 [105]	10.2 [100]
40	Ward Creek at Stanford Rock Trail crossing near Tahoe City, Calif.	1992–98	3 3	8.1 [95]	10.3 [99]	—
41	Ward Creek below confluence near Tahoe City, Calif.	1992–98	0	—	—	—

Nutrients and Suspended Sediment

Samples may have higher concentration values than from other studies in the basin, because LTIMP emphasized sampling during storm and snowmelt runoff. Summary statistics (minimums, maximums, medians, and number of samples) for nutrient and suspended-sediment concentrations from 10 primary, 10 secondary, and 14 miscellaneous sampling stations are listed in tables 10–16.

Dissolved nitrite plus nitrate nitrogen

Concentrations of dissolved nitrite plus nitrate nitrogen (table 10) ranged from less than 0.002 mg/L at three stations to 2.25 mg/L at Highway 50 Culvert to Edgewood Creek during storm runoff. For all stations, the highest median concentration was 0.134 mg/L at Highway 50 Culvert to Edgewood Creek and the lowest was 0.004 mg/L at Second Creek at Lakeshore Drive. For primary and secondary stations, the highest median concentration was 0.030 mg/L at Incline Creek near Crystal Bay and the lowest was 0.005 mg/L at Trout Creek at U.S. Forest Service Road 12N01 and General Creek near Meeks Bay. Concentrations of dissolved nitrite plus nitrate nitrogen made-up about 10 percent of the total nitrogen component for all stations. Dissolved nitrite plus nitrate nitrogen concentrations were observed to increase slightly in a downstream direction based on median values for the five multiple-station watersheds.

Dissolved ammonia nitrogen

Concentrations of dissolved ammonia nitrogen (table 11) were low, ranging from less than 0.003 mg/L at many stations to 1.39 mg/L at Edgewood Creek Tributary above Clubhouse during storm runoff. For all stations, the highest median concentration was 0.166 mg/L at Highway 50 Culvert to Edgewood Creek and the lowest was less than 0.003 mg/L at many stations. For primary and secondary stations, the highest median concentration was 0.003 mg/L at the three Edgewood Creek stations and the lowest was less than 0.003 mg/L at many stations. All stations had medians less than 0.003 mg/L except the eight stations in the Edgewood Creek watershed. In the Edgewood Creek watershed, ammonia did not increase in a downstream direction. Dissolved ammonia nitrogen made-up less than 1 percent of the total nitrogen component for all stations.

Total ammonia and organic nitrogen

Total ammonia and organic nitrogen concentrations (table 12) ranged from less than 0.04 to 24.0 mg/L; both values occurred at Third Creek near Crystal Bay, with the higher reading observed during summer thunderstorm runoff. For all stations, the highest median concentration was 4.15 mg/L at Highway 50 Culvert to Edgewood Creek and the lowest was 0.07 mg/L at Ward Creek below confluence. For primary and secondary stations, the highest median was 0.21 mg/L at Incline Creek near Crystal Bay and the lowest was 0.07 mg/L at Ward Creek below confluence. Total ammonia and organic nitrogen concentrations were observed to increase only slightly in a downstream direction.

Soluble reactive phosphorus

Concentrations of soluble reactive phosphorus (table 13) ranged from less than 0.001 mg/L at Logan House Creek near Glenbrook to 1.55 mg/L at Edgewood Creek Tributary above Clubhouse during storm runoff. For all stations, the highest median concentration was 0.090 mg/L at Highway 50 Culvert to Edgewood Creek and the lowest was 0.002 mg/L at Logan House Creek near Glenbrook. For primary and secondary stations, the highest median concentration was 0.013 mg/L at Glenbrook Creek at Glenbrook and the lowest was 0.002 mg/L at Logan House Creek near Glenbrook. Soluble reactive phosphorus concentrations made-up about 24 percent of the total phosphorus component. Soluble reactive phosphorus concentrations were observed to increase only slightly or not at all in a downstream direction.

Total phosphorus

Total phosphorus concentrations (table 14) ranged from less than 0.002 mg/L at Logan House Creek near Glenbrook to 11.1 mg/L at Highway 50 Culvert to Edgewood Creek during storm runoff. For all stations, the highest median concentration was 4.30 mg/L at Highway 50 Culvert to Edgewood Creek and the lowest was 0.0021 mg/L at three stations. For primary and secondary stations, the highest median concentration was 0.051 mg/L at Incline Creek near Crystal Bay and the lowest was 0.021 mg/L at several stations. Total phosphorus concentrations were observed to increase slightly in a downstream direction

Table 10. Dissolved nitrite plus nitrate nitrogen concentration data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada

[Abbreviation: mg/L, milligram per liter. Symbol: <, less than]

Map number	Station name	Period of record	Sample size	Dissolved nitrite + nitrate nitrogen (mg/L)		
				Minimum	Maximum	Median
	Incline Village area (fig. 2)					
1	First Creek (at Highway 28) near Crystal Bay, Nev.	1991–98	72	0.002	0.041	0.006
2	Second Creek at Lakeshore Dr. near Crystal Bay, Nev.	1991–98	69	.002	.021	.004
3	Wood Creek near mouth (at Lakeshore Dr.) near Crystal Bay, Nev.	1991–98	71	.002	.101	.016
4	Wood Creek above Jennifer St. near Incline Village, Nev.	1991–98	62	.003	.093	.018
5	Third Creek (at Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	438	<.002	.439	.014
6	Third Creek at Village Blvd. at Incline Village, Nev.	1991–98	68	.003	.050	.010
7	Third Creek below unnamed tributary near Incline Village, Nev.	1991–98	64	.002	.072	.014
8	Incline Creek (above Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	433	.003	.330	.030
9	Incline Creek at Highway 28 at Incline Village, Nev.	1990–98	232	.003	.082	.025
10	Incline Creek above Tyrol Village near Incline Village, Nev.	1990–98	243	.002	.101	.021
11	Incline Creek Tributary at County Club Dr. near Incline Village, Nev.	1991–98	84	.014	.151	.046
	Glenbrook area (fig. 3)					
12	Glenbrook Creek (near mouth) at Glenbrook, Nev.	1988–98	334	<.002	1.25	.010
13	Glenbrook Creek at Old Highway near Glenbrook, Nev.	1991–88	67	.002	.068	.007
14	Logan House Creek near Glenbrook, Nev.	1984–98	292	.002	.072	.013
15	North Logan House Creek above Highway 50 near Glenbrook, Nev.	1991–98	70	.002	.058	.018
	Stateline area (fig. 4)					
16	Edgewood Creek at Lake Tahoe near Stateline, Nev.	1989–98	174	.002	.184	.016
17	Edgewood Creek Tributary above Clubhouse near Stateline, Nev.	1995–98	8	.037	.491	.095
18	Culvert into Edgewood Creek above Highway 50 at Stateline, Nev.	1995–98	10	.061	2.25	.134

Table 10. Dissolved nitrite plus nitrate nitrogen concentration data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada—Continued

Map number	Station name	Period of record	Sample size	Dissolved nitrite + nitrate nitrogen (mg/L)		
				Minimum	Maximum	Median
	Stateline area (fig. 4)					
19	Edgewood Creek (at Highway 50) at Stateline, Nev.	1992–98	170	.002	.070	.019
20	Edgewood Creek at Palisade Dr. near Kingsbury, Nev.	1990–98	219	0.003	0.229	0.016
21	Eagle Rock Creek near Stateline, Nev.	1990–98	165	.002	.075	.011
22	Edgewood Creek Tributary near Daggett Pass, Nev.	1990–98	47	.003	.049	.006
23	Edgewood Creek below South Benjamin Dr. near Daggett Pass, Nev.	1990–98	76	.010	.101	.027
	South Lake Tahoe area (fig. 5)					
25	Trout Creek (at Highway 50) at South Lake Tahoe, Calif.	1993–98	168	.002	.044	.009
28	Trout Creek at Pioneer Trail near South Lake Tahoe, Calif.	1990–98	208	.002	.113	.006
29	Trout Creek at U.S. Forest Service Rd. 12N01 near Meyers, Calif.	1990–98	152	.002	.045	.005
31	Upper Truckee River (at Highway 50) at South Lake Tahoe, Calif.	1993–98	184	.002	.090	.012
33	Upper Truckee River at Highway 50 above Meyers, Calif.	1990–98	227	.002	.079	.009
36	Upper Truckee River at South Upper Truckee Rd. near Meyers, Calif.	1990–98	206	.002	.065	.012
	Tahoe City to Meeks Bay area (fig. 6)					
37	General Creek (at Highway 89) near Meeks Bay, Calif.	1993–98	210	.002	.033	.005
38	Blackwood Creek (at Highway 89) near Tahoe City, Calif.	1993–98	233	<.002	.091	.016
39	Ward Creek at Highway 89 near Tahoe Pines, Calif.	1993–98	232	.002	.072	.010
40	Ward Creek at Stanford Rock Trail crossing near Tahoe City, Calif.	1992–98	154	.002	.087	.009
41	Ward Creek below confluence near Tahoe City, Calif.	1992–98	143	.002	.107	.014

Table 11. Dissolved ammonia nitrogen concentration data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada

[Abbreviation: mg/L, milligram per liter. Symbol: <, less than]

Map number	Station name	Period of record	Sample size	Dissolved ammonia nitrogen (mg/L)		
				Minimum	Maximum	Median
	Incline Village area (fig. 2)					
1	First Creek (at Highway 28) near Crystal Bay, Nev.	1991–98	72	<0.003	0.010	<0.003
2	Second Creek at Lakeshore Dr. near Crystal Bay, Nev.	1991–98	69	<.003	.020	<.003
3	Wood Creek near mouth (at Lakeshore Dr.) near Crystal Bay, Nev.	1991–98	71	<.003	.043	<.003
4	Wood Creek above Jennifer St. near Incline Village, Nev.	1991–98	62	<.003	.014	<.003
5	Third Creek (at Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	437	<.003	.063	<.003
6	Third Creek at Village Blvd. at Incline Village, Nev.	1991–98	68	<.003	.009	<.003
7	Third Creek below unnamed tributary near Incline Village, Nev.	1991–98	64	<.003	.013	<.003
8	Incline Creek (above Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	431	<.003	.147	<.003
9	Incline Creek at Highway 28 at Incline Village, Nev.	1990–98	229	<.003	.052	<.003
10	Incline Creek above Tyrol Village near Incline Village, Nev.	1990–98	244	<.003	.055	<.003
11	Incline Creek Tributary at County Club Dr. near Incline Village, Nev.	1991–98	84	<.003	.015	<.003
	Glenbrook area (fig. 3)					
12	Glenbrook Creek (near mouth) at Glenbrook, Nev.	1988–98	333	<.003	.082	<.003
13	Glenbrook Creek at Old Highway near Glenbrook, Nev.	1991–88	67	<.003	.014	<.003
14	Logan House Creek near Glenbrook, Nev.	1984–98	291	<.003	.033	<.003
15	North Logan House Creek above Highway 50 near Glenbrook, Nev.	1991–98	70	<.003	.029	<.003
	Stateline area (fig. 4)					
16	Edgewood Creek at Lake Tahoe near Stateline, Nev.	1989–98	173	<.003	.346	.006
17	Edgewood Creek Tributary above Clubhouse near Stateline, Nev.	1995–98	8	.007	1.39	.144
18	Culvert into Edgewood Creek above Highway 50 at Stateline, Nev.	1995–98	10	.003	.566	.166
19	Edgewood Creek (at Highway 50) at Stateline, Nev.	1992–98	170	<.003	.178	.003

Table 11. Dissolved ammonia nitrogen concentration data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada—Continued

Map number	Station name	Period of record	Sample size	Dissolved ammonia nitrogen (mg/L)		
				Minimum	Maximum	Median
	Stateline area (fig. 4)					
20	Edgewood Creek at Palisade Dr. near Kingsbury, Nev.	1990–98	219	<0.003	0.045	0.003
21	Eagle Rock Creek near Stateline, Nev.	1990–98	165	<.003	.139	.003
22	Edgewood Creek Tributary near Daggett Pass, Nev.	1990–98	47	<.003	.014	.003
23	Edgewood Creek below South Benjamin Dr. near Daggett Pass, Nev.	1990–98	76	<.003	.058	.007
	South Lake Tahoe area (fig. 5)					
25	Trout Creek (at Highway 50) at South Lake Tahoe, Calif.	1993–98	169	<.003	.077	<.003
28	Trout Creek at Pioneer Trail near South Lake Tahoe, Calif.	1990–98	208	<.003	.021	<.003
29	Trout Creek at U.S. Forest Service Rd. 12N01 near Meyers, Calif.	1990–98	151	<.003	.026	<.003
31	Upper Truckee River (at Highway 50) at South Lake Tahoe, Calif.	1993–98	184	<.003	.027	<.003
33	Upper Truckee River at Highway 50 above Meyers, Calif.	1990–98	225	<.003	.099	<.003
36	Upper Truckee River at South Upper Truckee Rd. near Meyers, Calif.	1990–98	205	<.003	.030	<.003
	Tahoe City to Meeks Bay area (fig. 6)					
37	General Creek (at Highway 89) near Meeks Bay, Calif.	1993–98	209	<.003	.012	<.003
38	Blackwood Creek (at Highway 89) near Tahoe City, Calif.	1993–98	233	<.003	.118	<.003
39	Ward Creek at Highway 89 near Tahoe Pines, Calif.	1993–98	230	<.003	.018	<.003
40	Ward Creek at Stanford Rock Trail crossing near Tahoe City, Calif.	1992–98	154	<.003	.012	<.003
41	Ward Creek below confluence near Tahoe City, Calif.	1992–98	143	<.003	.016	<.003

Table 12. Total organic plus ammonia nitrogen concentration data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada

[Abbreviation: mg/L, milligram per liter. Symbol: <, less than]

Map number	Station name	Period of record	Sample size	Total organic + ammonia nitrogen (mg/L)		
				Minimum	Maximum	Median
	Incline Village area (fig. 2)					
1	First Creek (at Highway 28) near Crystal Bay, Nev.	1991–98	72	0.05	0.83	0.16
2	Second Creek at Lakeshore Dr. near Crystal Bay, Nev.	1991–98	69	.05	3.0	.16
3	Wood Creek near mouth (at Lakeshore Dr.) near Crystal Bay, Nev.	1991–98	71	.06	8.2	.19
4	Wood Creek above Jennifer St. near Incline Village, Nev.	1991–98	62	.05	1.9	.18
5	Third Creek (at Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	455	<.04	24.0	.20
6	Third Creek at Village Blvd. at Incline Village, Nev.	1991–98	68	<.04	1.9	.13
7	Third Creek below unnamed tributary near Incline Village, Nev.	1991–98	64	<.04	1.8	.14
8	Incline Creek (above Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	426	<.04	3.0	.21
9	Incline Creek at Highway 28 at Incline Village, Nev.	1990–98	232	<.04	1.7	.17
10	Incline Creek above Tyrol Village near Incline Village, Nev.	1990–98	245	<.04	3.0	.16
11	Incline Creek Tributary at County Club Dr. near Incline Village, Nev.	1991–98	84	.05	1.3	.17
	Glenbrook area (fig. 3)					
12	Glenbrook Creek (near mouth) at Glenbrook, Nev.	1988–98	329	.06	6.0	.20
13	Glenbrook Creek at Old Highway near Glenbrook, Nev.	1991–88	66	.06	.62	.15
14	Logan House Creek near Glenbrook, Nev.	1984–98	289	<.04	1.7	.20
15	North Logan House Creek above Highway 50 near Glenbrook, Nev.	1991–98	70	.04	1.1	.22
	Stateline area (fig. 4)					
16	Edgewood Creek at Lake Tahoe near Stateline, Nev.	1989–98	177	.07	2.0	.32
17	Edgewood Creek Tributary above Clubhouse near Stateline, Nev.	1995–98	8	.39	5.5	1.65
18	Culvert into Edgewood Creek above Highway 50 at Stateline, Nev.	1995–98	10	.34	14.0	4.15

Table 12. Total organic plus ammonia nitrogen concentration data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada—Continued

Map number	Station name	Period of record	Sample size	Total organic + ammonia nitrogen (mg/L)		
				Minimum	Maximum	Median
	Stateline area (fig. 4)					
19	Edgewood Creek (at Highway 50) at Stateline, Nev.	1992–98	170	0.04	1.1	0.19
20	Edgewood Creek at Palisade Dr. near Kingsbury, Nev.	1990–98	219	.05	5.9	.19
21	Eagle Rock Creek near Stateline, Nev.	1990–98	167	.04	16.0	.13
22	Edgewood Creek Tributary near Daggett Pass, Nev.	1990–98	47	.12	0.58	.26
23	Edgewood Creek below South Benjamin Dr. near Daggett Pass, Nev.	1990–98	75	.04	1.7	.25
	South Lake Tahoe area (fig. 5)					
25	Trout Creek (at Highway 50) at South Lake Tahoe, Calif.	1993–98	167	<.04	2.1	.19
28	Trout Creek at Pioneer Trail near South Lake Tahoe, Calif.	1990–98	211	<.04	2.8	.16
29	Trout Creek at U.S. Forest Service Rd. 12N01 near Meyers, Calif.	1990–98	154	.04	6.6	.12
31	Upper Truckee River (at Highway 50) at South Lake Tahoe, Calif.	1993–98	183	.05	1.2	.16
33	Upper Truckee River at Highway 50 above Meyers, Calif.	1990–98	227	<.04	1.0	.11
36	Upper Truckee River at South Upper Truckee Rd. near Meyers, Calif.	1990–98	207	.04	.87	.12
	Tahoe City to Meeks Bay area (fig. 6)					
37	General Creek (at Highway 89) near Meeks Bay, Calif.	1993–98	209	.04	.57	.12
38	Blackwood Creek (at Highway 89) near Tahoe City, Calif.	1993–98	231	<.04	1.7	.14
39	Ward Creek at Highway 89 near Tahoe Pines, Calif.	1993–98	230	<.04	1.2	.12
40	Ward Creek at Stanford Rock Trail crossing near Tahoe City, Calif.	1992–98	152	<.04	.90	.10
41	Ward Creek below confluence near Tahoe City, Calif.	1992–98	141	<.04	1.4	.07

Table 13. Soluble reactive phosphorus concentration data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada

[Abbreviation: mg/L, milligram per liter. Symbol: <, less than]

Map number	Station name	Period of record	Sample size	Soluble reactive phosphorus (mg/L)		
				Minimum	Maximum	Median
	Incline Village area (fig. 2)					
1	First Creek (at Highway 28) near Crystal Bay, Nev.	1991–98	72	0.005	0.046	0.010
2	Second Creek at Lakeshore Dr. near Crystal Bay, Nev.	1991–98	69	.011	.043	.017
3	Wood Creek near mouth (at Lakeshore Dr.) near Crystal Bay, Nev.	1991–98	71	.005	.066	.018
4	Wood Creek above Jennifer St. near Incline Village, Nev.	1991–98	62	.006	.033	.017
5	Third Creek (at Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	437	.001	.048	.008
6	Third Creek at Village Blvd. at Incline Village, Nev.	1991–98	68	.002	.030	.008
7	Third Creek below unnamed tributary near Incline Village, Nev.	1991–98	64	.003	.030	.008
8	Incline Creek (above Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	432	.003	.073	.011
9	Incline Creek at Highway 28 at Incline Village, Nev.	1990–98	233	.003	.074	.012
10	Incline Creek above Tyrol Village near Incline Village, Nev.	1990–98	243	.001	.086	.011
11	Incline Creek Tributary at County Club Dr. near Incline Village, Nev.	1991–98	83	.003	.025	.009
	Glenbrook area (fig. 3)					
12	Glenbrook Creek (near mouth) at Glenbrook, Nev.	1988–98	333	.001	.087	.013
13	Glenbrook Creek at Old Highway near Glenbrook, Nev.	1991–88	66	.002	.028	.013
14	Logan House Creek near Glenbrook, Nev.	1984–98	291	<.001	.019	.002
15	North Logan House Creek above Highway 50 near Glenbrook, Nev.	1991–98	69	.002	.017	.006
	Stateline area (fig. 4)					
16	Edgewood Creek at Lake Tahoe near Stateline, Nev.	1989–98	174	.003	.243	.014
17	Edgewood Creek Tributary above Clubhouse near Stateline, Nev.	1995–98	8	.020	1.55	.084
18	Culvert into Edgewood Creek above Highway 50 at Stateline, Nev.	1995–98	10	.012	.206	.090

Table 13. Soluble reactive phosphorus concentration data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada—Continued

Map number	Station name	Period of record	Sample size	Soluble reactive phosphorus (mg/L)		
				Minimum	Maximum	Median
	Stateline area (fig. 4)					
19	Edgewood Creek (at Highway 50) at Stateline, Nev.	1992–98	170	0.007	0.045	0.012
20	Edgewood Creek at Palisade Dr. near Kingsbury, Nev.	1990–98	219	.003	.179	.010
21	Eagle Rock Creek near Stateline, Nev.	1990–98	165	.003	.067	.010
22	Edgewood Creek Tributary near Daggett Pass, Nev.	1990–98	47	.002	.023	.010
23	Edgewood Creek below South Benjamin Dr. near Daggett Pass, Nev.	1990–98	76	.003	.032	.011
	South Lake Tahoe area (fig. 5)					
25	Trout Creek (at Highway 50) at South Lake Tahoe, Calif.	1993–98	168	.003	.030	.009
28	Trout Creek at Pioneer Trail near South Lake Tahoe, Calif.	1990–98	208	.002	.023	.009
29	Trout Creek at U.S. Forest Service Rd. 12N01 near Meyers, Calif.	1990–98	151	.004	.033	.008
31	Upper Truckee River (at Highway 50) at South Lake Tahoe, Calif.	1993–98	184	.001	.032	.005
33	Upper Truckee River at Highway 50 above Meyers, Calif.	1990–98	225	.001	.034	.007
36	Upper Truckee River at South Upper Truckee Rd. near Meyers, Calif.	1990–98	205	.001	.017	.004
	Tahoe City to Meeks Bay area (fig. 6)					
37	General Creek (at Highway 89) near Meeks Bay, Calif.	1993–98	209	.001	.030	.004
38	Blackwood Creek (at Highway 89) near Tahoe City, Calif.	1993–98	232	.001	.014	.005
39	Ward Creek at Highway 89 near Tahoe Pines, Calif.	1993–98	231	.002	.034	.007
40	Ward Creek at Stanford Rock Trail crossing near Tahoe City, Calif.	1992–98	154	.001	.021	.007
41	Ward Creek below confluence near Tahoe City, Calif.	1992–98	143	.001	.016	.005

Table 14. Total phosphorus concentration data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada

[Abbreviation: mg/L, milligram per liter. Symbol: <, less than]

Map number	Station name	Period of record	Sample size	Total phosphorus (mg/L)		
				Minimum	Maximum	Median
	Incline Village area (fig. 2)					
1	First Creek (at Highway 28) near Crystal Bay, Nev.	1991–98	72	0.018	0.308	0.045
2	Second Creek at Lakeshore Dr. near Crystal Bay, Nev.	1991–98	72	.027	1.29	.069
3	Wood Creek near mouth (at Lakeshore Dr.) near Crystal Bay, Nev.	1991–98	71	.023	4.58	.085
4	Wood Creek above Jennifer St. near Incline Village, Nev.	1991–98	62	.032	.848	.074
5	Third Creek (at Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	440	.002	9.42	.048
6	Third Creek at Village Blvd. at Incline Village, Nev.	1991–98	68	.014	1.30	.042
7	Third Creek below unnamed tributary near Incline Village, Nev.	1991–98	64	.014	2.00	.035
8	Incline Creek (above Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	432	.004	1.19	.051
9	Incline Creek at Highway 28 at Incline Village, Nev.	1990–98	233	.007	1.02	.050
10	Incline Creek above Tyrol Village near Incline Village, Nev.	1990–98	246	.014	.368	.036
11	Incline Creek Tributary at County Club Dr. near Incline Village, Nev.	1991–98	84	.024	.361	.046
	Glenbrook area (fig. 3)					
12	Glenbrook Creek (near mouth) at Glenbrook, Nev.	1988–98	334	.008	1.98	.041
13	Glenbrook Creek at Old Highway near Glenbrook, Nev.	1991–88	67	.016	.283	.038
14	Logan House Creek near Glenbrook, Nev.	1984–98	393	<.002	.261	.021
15	North Logan House Creek above Highway 50 near Glenbrook, Nev.	1991–98	70	.015	.114	.032
	Stateline area (fig. 4)					
16	Edgewood Creek at Lake Tahoe near Stateline, Nev.	1989–98	176	.016	.811	.055
17	Edgewood Creek Tributary above Clubhouse near Stateline, Nev.	1995–98	8	.049	2.16	.262
18	Culvert into Edgewood Creek above Highway 50 at Stateline, Nev.	1995–98	10	.485	11.1	4.30
19	Edgewood Creek (at Highway 50) at Stateline, Nev.	1992–98	170	.009	.507	.041

Table 14. Total phosphorus concentration data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada—Continued

Map number	Station name	Period of record	Sample size	Total phosphorus (mg/L)		
				Minimum	Maximum	Median
	Stateline area (fig. 4)					
20	Edgewood Creek at Palisade Dr. near Kingsbury, Nev.	1990–98	221	0.007	3.92	0.043
21	Eagle Rock Creek near Stateline, Nev.	1990–98	167	.007	8.34	.033
22	Edgewood Creek Tributary near Daggett Pass, Nev.	1990–98	47	.015	.140	.030
23	Edgewood Creek below South Benjamin Dr. near Daggett Pass, Nev.	1990–98	76	.016	1.16	.065
	South Lake Tahoe area (fig. 5)					
25	Trout Creek (at Highway 50) at South Lake Tahoe, Calif.	1993–98	168	.003	.393	.040
28	Trout Creek at Pioneer Trail near South Lake Tahoe, Calif.	1990–98	211	.014	.453	.031
29	Trout Creek at U.S. Forest Service Rd. 12N01 near Meyers, Calif.	1990–98	152	.004	1.75	.027
31	Upper Truckee River (at Highway 50) at South Lake Tahoe, Calif.	1993–98	184	.004	.230	.031
33	Upper Truckee River at Highway 50 above Meyers, Calif.	1990–98	227	.009	.147	.026
36	Upper Truckee River at South Upper Truckee Rd. near Meyers, Calif.	1990–98	206	.009	.248	.021
	Tahoe City to Meeks Bay area (fig. 6)					
37	General Creek (at Highway 89) near Meeks Bay, Calif.	1993–98	210	.007	.351	.021
38	Blackwood Creek (at Highway 89) near Tahoe City, Calif.	1993–98	233	.010	1.88	.037
39	Ward Creek at Highway 89 near Tahoe Pines, Calif.	1993–98	232	.008	2.14	.036
40	Ward Creek at Stanford Rock Trail crossing near Tahoe City, Calif.	1992–98	155	.008	1.01	.029
41	Ward Creek below confluence near Tahoe City, Calif.	1992–98	143	.005	1.63	.021

in the Incline, Trout, and Ward Creeks and Upper Truckee River watersheds, and decrease slightly in a downstream direction in the Edgewood Creek watershed.

Biologically reactive iron

Concentrations of biologically reactive iron (table 15) ranged from 8 micrograms per liter (µg/L) at Ward Creek at Highway 89 and below confluence stations to 131,000 µg/L at Highway 50 Culvert to Edgewood Creek during storm runoff. For all stations, the highest median concentration was 44,200 µg/L at Highway 50 Culvert to Edgewood Creek and the lowest was 63 µg/L at Ward Creek below confluence. For primary and secondary stations, the highest median concentration was 1,120 µg/L at Third Creek near Crystal Bay and the lowest was 63 µg/L at Ward Creek below confluence. Iron concentrations were observed to increase in a downstream direction in the Incline, Trout, and Ward Creeks and Upper Truckee River watersheds, and decrease in a downstream direction in the Edgewood Creek watershed.

Suspended Sediment

Suspended-sediment concentrations (table 16) ranged from less than 1 mg/L at five stations to 12,500 mg/L at Highway 50 Culvert to Edgewood Creek during storm runoff. For all stations, the highest median concentration was 3,900 mg/L at Highway 50 Culvert to Edgewood Creek and the lowest was 3 mg/L at three stations. For primary and secondary stations, the highest median concentration was 59.5 mg/L at Third Creek near Crystal Bay and the lowest was 3 mg/L at Logan House Creek near Glenbrook and Upper Truckee River at Highway 50 above Meyers. Suspended sediment increased in a downstream direction in the Incline, Trout, and Ward Creeks and Upper Truckee River watersheds, and decreased in a downstream direction in the Edgewood Creek watershed.

Concentration Versus Time and Streamflow

Nutrient and suspended-sediment concentrations for the two index stations, Incline Creek near Crystal Bay and Upper Truckee River at South Lake Tahoe, are shown as time-series plots in figures 13 and 14. The data in these figures exhibit wide scatter, especially for the Incline Creek stations, and trends are difficult to discern. Nutrient and suspended-sediment concentrations versus streamflow for the two index stations are plotted in figures 15 and 16. The data in these plots exhibit wide scatter also; relations between concentration and streamflow are complex.

Load Estimations

Comparison of Nutrient and Suspended-Sediment Load Estimations

A non-parametric Wilcoxon signed-rank test (Helsel and Hirsch, 1992) was performed on the ESTIMATOR and FLUX estimates for each constituent across the 10 primary stations for the study period. Comparisons between ESTIMATOR and FLUX load estimation programs for the 10 primary stations are listed in table 17. The results of the two load estimation programs were found to be not significantly different for only three of the seven constituents tested. The range of difference was from -96 to 710 percent.

Examination of table 17 shows ESTIMATOR-FLUX monthly load differences of dissolved nitrite plus nitrate nitrogen ranged from -39 to 17 percent and the Wilcoxon test found the loads not to be statistically different. Dissolved ammonia nitrogen load differences ranged from -33 to 119 percent and the Wilcoxon test found the loads to be statistically different. Total nitrogen load differences ranged from -13 to -2 percent and the Wilcoxon test found the loads to be statistically different. Soluble reactive phosphorus load differences ranged from -78 to 4 percent and the Wilcoxon test found the loads to be statistically different. Total phosphorus load differences ranged from -65 to -3 percent and the Wilcoxon test found the results to be statistically different. Biologically reactive iron load differences ranged from -96 to 90 percent and the Wilcoxon test found the loads not to be statistically different. Suspended-sediment loads differences ranged from -33 to 710 percent and the Wilcoxon test found the loads not to be statistically different.

Monthly Loads from Primary and Secondary Stations

Summary statistics (median, maximum, and minimum) for estimated monthly loads of nutrients (from ESTIMATOR) and suspended sediment (from FLUX) for the 10 primary and 10 secondary stations for various periods of record are listed in tables 18–23 and discussed below.

Table 15. Biologically reactive iron concentration data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada

[Abbreviation: µg/L, microgram per liter. Symbol: <, less than]

Map number	Station name	Period of record	Sample size	Biologically reactive iron (µg/L)		
				Minimum	Maximum	Median
	Incline Village area (fig. 2)					
1	First Creek (at Highway 28) near Crystal Bay, Nev.	1991–98	71	40	4,880	513
2	Second Creek at Lakeshore Dr. near Crystal Bay, Nev.	1991–98	69	110	20,000	807
3	Wood Creek near mouth (at Lakeshore Dr.) near Crystal Bay, Nev.	1991–98	69	193	63,700	786
4	Wood Creek above Jennifer St. near Incline Village, Nev.	1991–98	61	148	8,350	679
5	Third Creek (at Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	308	219	33,300	1,120
6	Third Creek at Village Blvd. at Incline Village, Nev.	1991–98	68	220	14,300	618
7	Third Creek below unnamed tributary near Incline Village, Nev.	1991–98	64	22	18,000	437
8	Incline Creek (above Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	303	193	28,500	973
9	Incline Creek at Highway 28 at Incline Village, Nev.	1990–98	207	67	23,700	824
10	Incline Creek above Tyrol Village near Incline Village, Nev.	1990–98	195	67	4,700	242
11	Incline Creek Tributary at County Club Dr. near Incline Village, Nev.	1991–98	82	267	8,170	564
	Glenbrook area (fig. 3)					
12	Glenbrook Creek (near mouth) at Glenbrook, Nev.	1988–98	230	43	27,700	484
13	Glenbrook Creek at Old Highway near Glenbrook, Nev.	1991–88	66	43	9,450	248
14	Logan House Creek near Glenbrook, Nev.	1984–98	189	18	2,750	93
15	North Logan House Creek above Highway 50 near Glenbrook, Nev.	1991–98	69	73	2,920	371
	Stateline area (fig. 4)					
16	Edgewood Creek at Lake Tahoe near Stateline, Nev.	1989–98	113	85	7,100	612
17	Edgewood Creek Tributary above Clubhouse near Stateline, Nev.	1995–98	8	646	6,300	1,560
18	Culvert into Edgewood Creek above Highway 50 at Stateline, Nev.	1995–98	10	14,900	131,000	44,200
19	Edgewood Creek (at Highway 50) at Stateline, Nev.	1992–98	168	34	6,540	588

Table 15. Biologically reactive iron concentration data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada—Continued

Map number	Station name	Period of record	Sample size	Biologically reactive iron (µg/L)		
				Minimum	Maximum	Median
	Stateline area (fig. 4)					
20	Edgewood Creek at Palisade Dr. near Kingsbury, Nev.	1990–98	204	166	41,400	698
21	Eagle Rock Creek near Stateline, Nev.	1990–98	151	70	57,600	250
22	Edgewood Creek Tributary near Daggett Pass, Nev.	1990–98	45	18	3,600	139
23	Edgewood Creek below South Benjamin Dr. near Daggett Pass, Nev.	1990–98	73	145	22,400	2,000
	South Lake Tahoe area (fig. 5)					
25	Trout Creek (at Highway 50) at South Lake Tahoe, Calif.	1993–98	167	103	8,750	571
28	Trout Creek at Pioneer Trail near South Lake Tahoe, Calif.	1990–98	197	94	12,100	368
29	Trout Creek at U.S. Forest Service Rd. 12N01 near Meyers, Calif.	1990–98	140	51	17,900	158
31	Upper Truckee River (at Highway 50) at South Lake Tahoe, Calif.	1993–98	182	53	4,210	373
33	Upper Truckee River at Highway 50 above Meyers, Calif.	1990–98	213	46	4,560	140
36	Upper Truckee River at South Upper Truckee Rd. near Meyers, Calif.	1990–98	193	38	5,500	212
	Tahoe City to Meeks Bay area (fig. 6)					
37	General Creek (at Highway 89) near Meeks Bay, Calif.	1993–98	208	32	7,650	143
38	Blackwood Creek (at Highway 89) near Tahoe City, Calif.	1993–98	231	73	14,800	448
39	Ward Creek at Highway 89 near Tahoe Pines, Calif.	1993–98	230	8	33,900	210
40	Ward Creek at Stanford Rock Trail crossing near Tahoe City, Calif.	1992–98	153	16	9,670	177
41	Ward Creek below confluence near Tahoe City, Calif.	1992–98	142	8	10,600	63

Table 16. Suspended-sediment concentration data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada

[Abbreviation: mg/L, milligram per liter. Symbol: <, less than]

Map number	Station name	Period of record	Sample size	Suspended sediment (mg/L)		
				Minimum	Maximum	Median
	Incline Village area (fig. 2)					
1	First Creek (at Highway 28) near Crystal Bay, Nev.	1991–98	72	1	644	18
2	Second Creek at Lakeshore Dr. near Crystal Bay, Nev.	1991–98	69	2	2,300	39
3	Wood Creek near mouth (at Lakeshore Dr.) near Crystal Bay, Nev.	1991–98	71	1	4,500	45
4	Wood Creek above Jennifer St. near Incline Village, Nev.	1991–98	62	1	1,270	46
5	Third Creek (at Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	392	1	3,930	60
6	Third Creek at Village Blvd. at Incline Village, Nev.	1991–98	69	1	1,080	35
7	Third Creek below unnamed tributary near Incline Village, Nev.	1991–98	65	1	2,480	19
8	Incline Creek (above Lakeshore Dr.) near Crystal Bay, Nev.	1988–98	381	1	1,840	24
9	Incline Creek at Highway 28 at Incline Village, Nev.	1990–98	232	1	1,530	16
10	Incline Creek above Tyrol Village near Incline Village, Nev.	1990–98	245	1	443	7
11	Incline Creek Tributary at County Club Dr. near Incline Village, Nev.	1991–98	85	3	348	14
	Glenbrook area (fig. 3)					
12	Glenbrook Creek (near mouth) at Glenbrook, Nev.	1988–98	290	1	606	6
13	Glenbrook Creek at Old Highway near Glenbrook, Nev.	1991–88	68	1	187	4
14	Logan House Creek near Glenbrook, Nev.	1984–98	255	1	388	3
15	North Logan House Creek above Highway 50 near Glenbrook, Nev.	1991–98	70	1	547	9
	Stateline area (fig. 4)					
16	Edgewood Creek at Lake Tahoe near Stateline, Nev.	1989–98	177	2	325	5
17	Edgewood Creek Tributary above Clubhouse near Stateline, Nev.	1995–98	8	17	272	59
18	Culvert into Edgewood Creek above Highway 50 at Stateline, Nev.	1995–98	8	630	12,500	3,900
19	Edgewood Creek (at Highway 50) at Stateline, Nev.	1992–98	167	1	130	5

Table 16. Suspended-sediment concentration data for current USGS LTIMP surface-water quality sampling/gaging stations and miscellaneous water-quality stations, by area, in the Lake Tahoe Basin, California and Nevada—Continued

Map number	Station name	Period of record	Sample size	Suspended sediment (mg/L)		
				Minimum	Maximum	Median
	Stateline area (fig. 4)					
20	Edgewood Creek at Palisade Dr. near Kingsbury, Nev.	1990–98	221	1	3,320	9
21	Eagle Rock Creek near Stateline, Nev.	1990–98	167	1	4,070	7
22	Edgewood Creek Tributary near Daggett Pass, Nev.	1990–98	47	<1	154	3
23	Edgewood Creek below South Benjamin Dr. near Daggett Pass, Nev.	1990–98	77	1	2,080	25
	South Lake Tahoe area (fig. 5)					
25	Trout Creek (at Highway 50) at South Lake Tahoe, Calif.	1993–98	173	2	335	14
28	Trout Creek at Pioneer Trail near South Lake Tahoe, Calif.	1990–98	211	1	499	7
29	Trout Creek at U.S. Forest Service Rd. 12N01 near Meyers, Calif.	1990–98	152	1	642	5
31	Upper Truckee River (at Highway 50) at South Lake Tahoe, Calif.	1993–98	187	1	458	16
33	Upper Truckee River at Highway 50 above Meyers, Calif.	1990–98	230	<1	155	3
36	Upper Truckee River at South Upper Truckee Rd. near Meyers, Calif.	1990–98	209	<1	176	4
	Tahoe City to Meeks Bay area (fig. 6)					
37	General Creek (at Highway 89) near Meeks Bay, Calif.	1993–98	208	1	1,620	8
38	Blackwood Creek (at Highway 89) near Tahoe City, Calif.	1993–98	231	1	2,840	21
39	Ward Creek at Highway 89 near Tahoe Pines, Calif.	1993–98	231	1	3,000	12
40	Ward Creek at Stanford Rock Trail crossing near Tahoe City, Calif.	1992–98	153	<1	452	6
41	Ward Creek below confluence near Tahoe City, Calif.	1992–98	140	<1	440	5

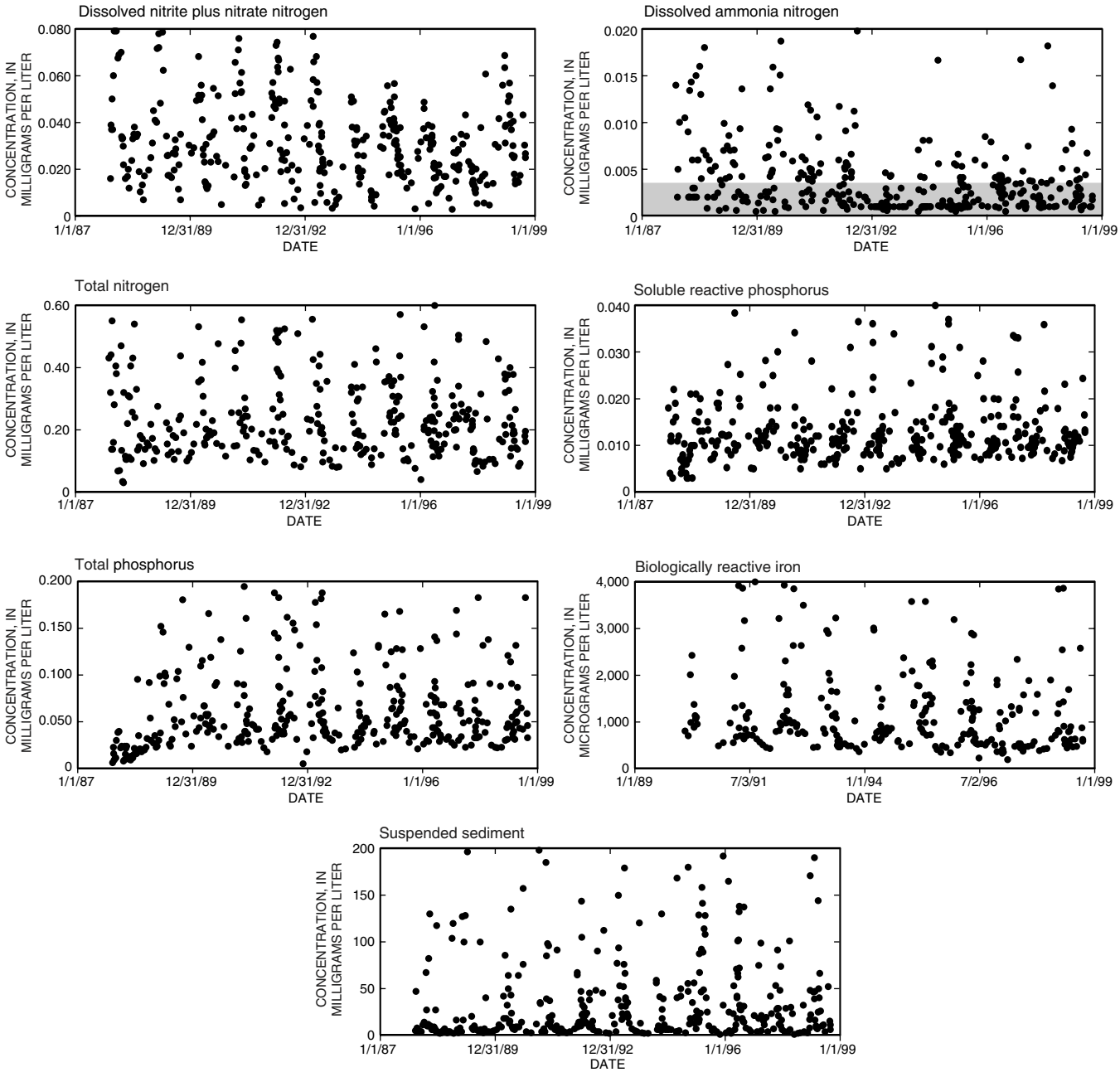

Figure 13. Time-series plots of nutrient and suspended-sediment concentrations for Incline Creek near Crystal Bay.
Note: Data in shaded area are below method reporting level.

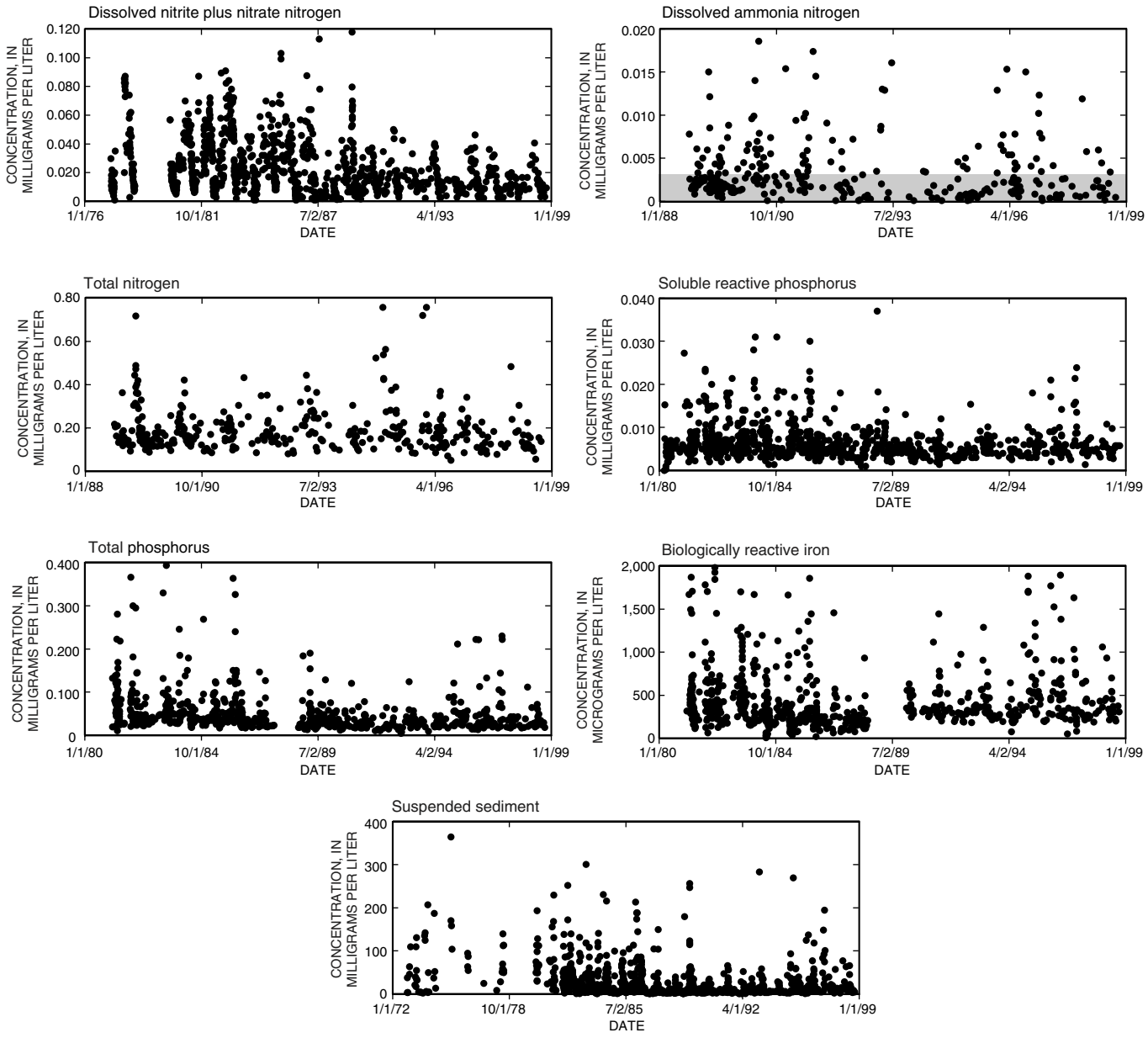

Figure 14. Time-series plots of nutrient and suspended-sediment concentrations for Upper Truckee River at South Lake Tahoe. **Note**: Data in shaded area are below method reporting level.

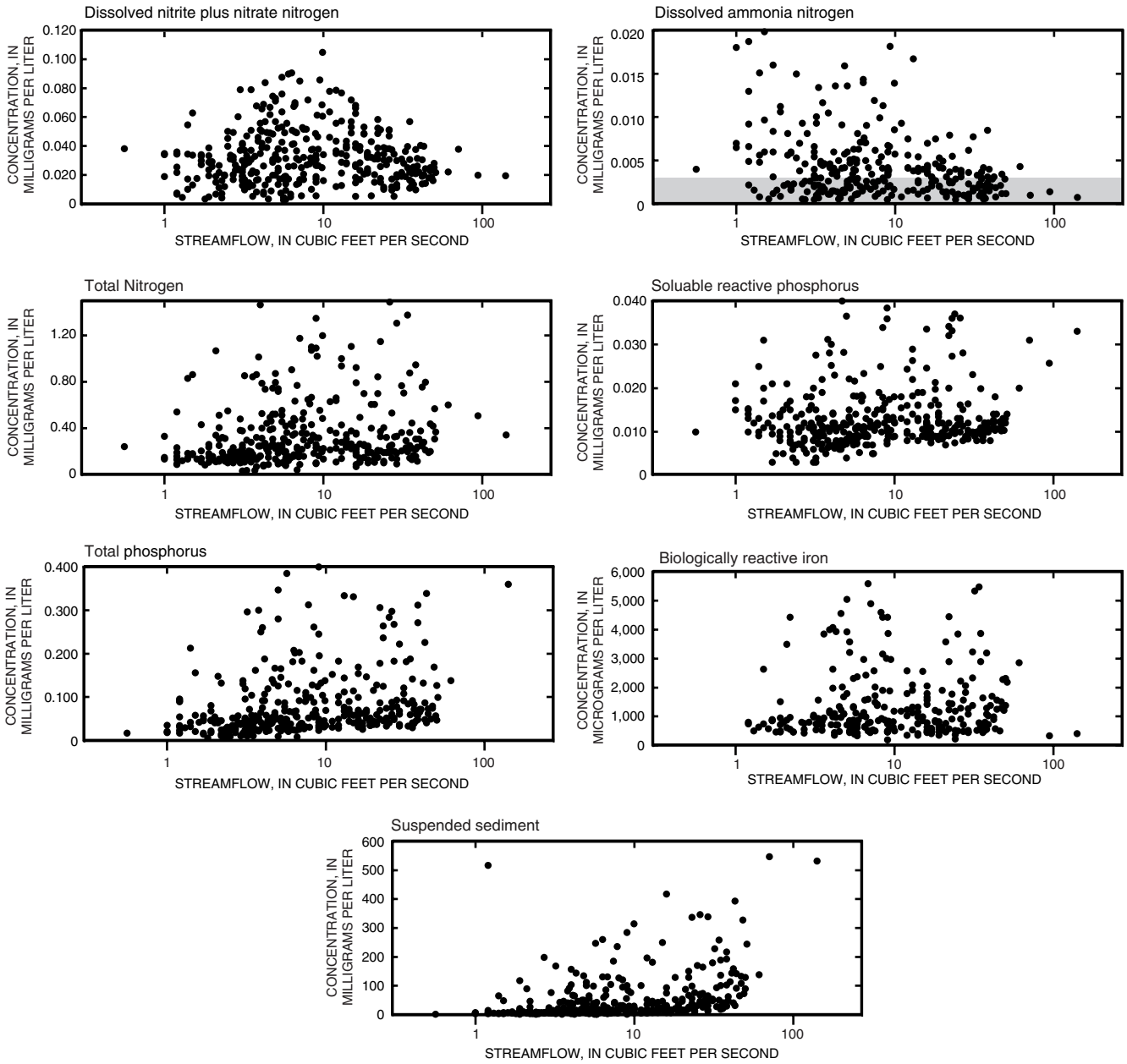

Figure 15. Plots of nutrient and suspended-sediment concentrations versus streamflow for Incline Creek near Crystal Bay. **Note**: Data in shaded area are below method reporting level.

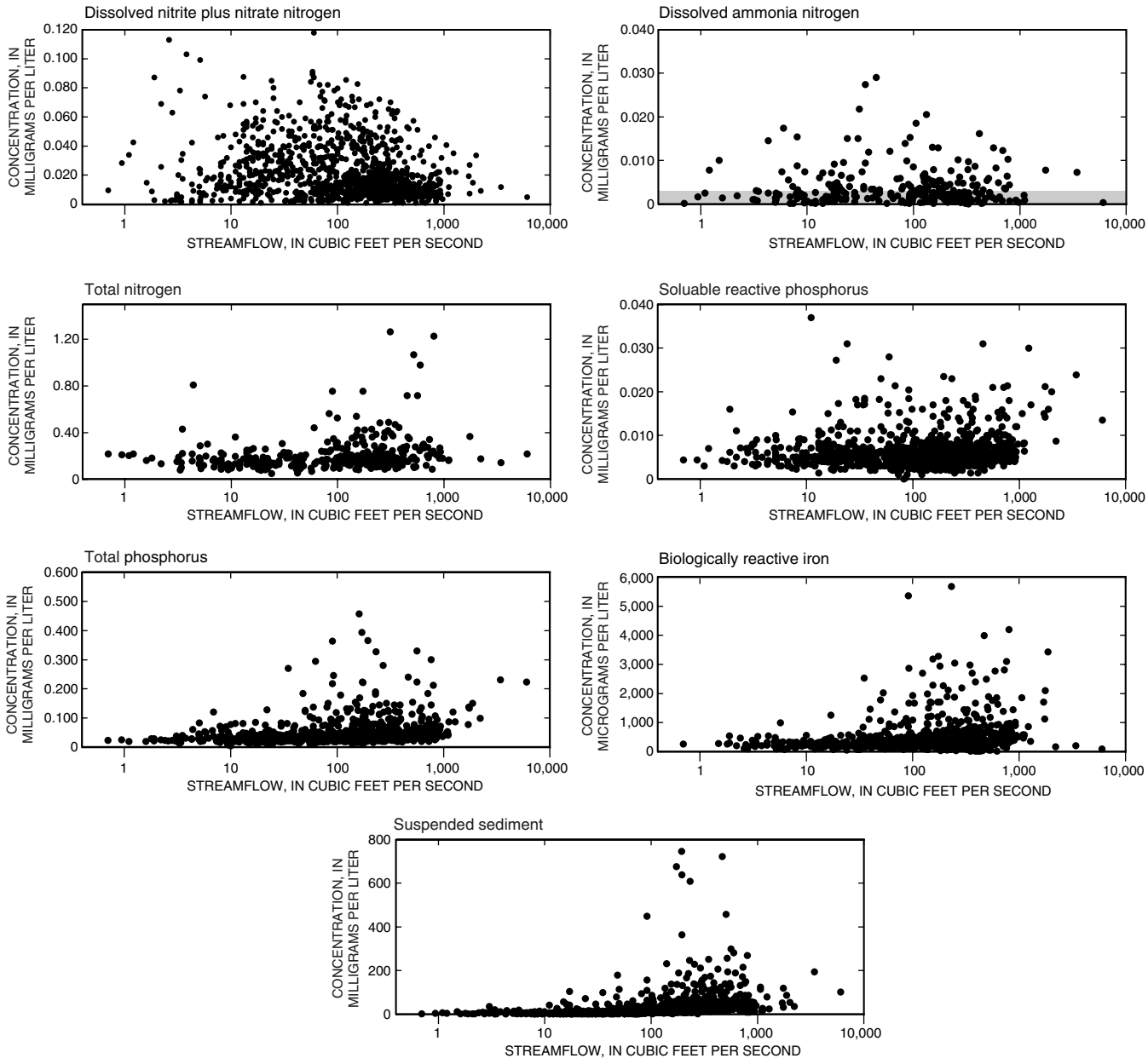

Figure 16. Plots of nutrient and suspended-sediment concentrations versus streamflow for Upper Truckee River at South Lake Tahoe. **Note**: Data in shaded area are below method reporting level.

Table 17. Comparison of monthly load summary statistics (sum, median, maximum, and minimum) and percent difference for load-estimation programs, ESTIMATOR and FLUX, for the 10 primary LTIMP sampling stations, through water year 1998, Lake Tahoe Basin, California and Nevada

[Abbreviation: kg, kilogram]

	Third Creek near Crystal Bay		Incline Creek near Crystal Bay		Glenbrook Creek at Glenbrook		Logan House Creek near Glenbrook		Edgewood Creek at Stateline	
	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)
Dissolved nitrite + nitrate nitrogen										
Sum	1,550	1,530	3,320	2,320	523	317	55.8	65.2	554	538
Median	5.95	5.91	15.8	9.65	1.65	.83	.10	.20	6.35	5.20
Maximum	83.8	85.7	134	86.4	32.9	17.1	3.70	3.49	25.2	25.8
Minimum	1.50	.88	4.30	1.30	0	.04	0	.01	1.80	1.31
Percent difference in sum		1		-30		-39		17		-3
Dissolved ammonia nitrogen										
Sum	300	208	349	272	66.2	55.5	11.8	25.9	258	294
Median	1.40	1.08	1.90	1.46	.40	.25	0	.06	2.60	1.72
Maximum	11.7	7.88	8.00	10.5	2.10	3.17	.90	1.74	19.0	53.7
Minimum	.50	.20	.90	.29	0	.01	0	.01	.30	.11
Percent difference in sum		-31		-22		-16		119		14
Total nitrogen										
Sum	35,200	31,100	29,200	27,000	5,210	4,950	1,460	1,360	6,770	6,270
Median	117	117	101	95.4	13.9	12.4	2.75	2.65	76.2	53.1
Maximum	2,335	1,900	1,743	1,947	342	428	130	125	405	425
Minimum	27.3	10.3	18.2	15.3	.30	0.15	0	.07	17.8	13.5
Percent difference in sum		-12		-8		-5		-7		-7
Soluble reactive phosphorus										
Sum	798	827	1,180	1,170	249	256	104	23.3	347	342
Median	3.10	3.07	4.80	5.17	.80	0.74	.80	.05	4.05	3.82
Maximum	41.0	55.2	58.8	69.4	15.4	18.8	2.90	2.08	24.5	27.5
Minimum	.70	.64	1.10	1.03	0	.02	0	.01	1.50	1.40
Percent difference in sum		4		-1		3		-78		-1

Table 17. Comparison of monthly load summary statistics (sum, median, maximum, and minimum) and percent difference for load-estimation programs, ESTIMATOR and FLUX, for the 10 primary LTIMP sampling stations, through water year 1998, Lake Tahoe Basin, California and Nevada—Continued

	Third Creek near Crystal Bay		Incline Creek near Crystal Bay		Glenbrook Creek at Glenbrook		Logan House Creek near Glenbrook		Edgewood Creek at Stateline	
	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)
Total phosphorus										
Sum	8,930	8,180	7,300	6,990	2,630	1,150	147	142	1,580	1,520
Median	26.0	24.2	25.3	22.9	10.5	2.59	.20	.24	17.2	14.6
Maximum	875	576	550	610	156	135	15.4	14.3	169	166
Minimum	6.20	3.55	4.00	2.30	.40	.09	0	.02	4.30	4.30
Percent difference in sum		-8		-4		-56		-3		-4
Biologically reactive iron										
Sum	124,000	132,000	121,000	103,000	91,600	13,400	1,480	1,380	24,100	23,300
Median	580	716	463	544	433	64.9	1.20	1.30	279	233
Maximum	15,700	6,980	6,520	6,410	6,430	1,210	201	198	1,310	1,150
Minimum	130	97.5	96.8	76.1	17.7	.62	0	.04	70.4	47.9
Percent difference in sum		-6		-15		-85		-7		-3
Suspended sediment										
Sum	17,500,000	18,200,000	8,370,000	5,630,000	438,000	433,000	83,200	242,000	431,000	371,000
Median	21,200	21,000	35,300	7,530	559	436	36.8	93.6	4,450	2,120
Maximum	2,080,00	2,610,000	397,000	906,000	42,700	137,000	13,500	45,300	30,000	87,400
Minimum	1,840	1,240	8,380	678	6.20	10.9	0	2.70	631	299
Percent difference in sum		4		-33		-1		191		-14

	Trout Creek at South Lake Tahoe		Upper Truckee River at South Lake Tahoe		General Creek near Meeks Bay		Blackwood Creek near Tahoe City		Ward Creek at State Highway 89	
	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)
Dissolved nitrite + nitrate nitrogen										
Sum	9,320	8,880	22,100	22,900	1,220	1,340	11,700	12,100	3,030	3,560
Median	27.4	28.8	59.2	64.0	1.55	2.32	12.8	12.4	3.65	3.66
Maximum	316	188	729	848	55.9	55.4	508	783	179	608
Minimum	4.60	3.23	2.20	1.08	.20	.14	1.40	.43	0	.02
Percent difference in sum		-5		4		10		3		17

Table 17. Comparison of monthly load summary statistics (sum, median, maximum, and minimum) and percent difference for load-estimation programs, ESTIMATOR and FLUX, for the 10 primary LTIMP sampling stations, through water year 1998, Lake Tahoe Basin, California and Nevada—Continued

	Trout Creek at South Lake Tahoe		Upper Truckee River at South Lake Tahoe		General Creek near Meeks Bay		Blackwood Creek near Tahoe City		Ward Creek at State Highway 89	
	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)
Dissolved ammonia nitrogen										
Sum	1,310	883	3,530	2,740	385	313	1,140	1,080	591	513
Median	9.45	5.74	13.6	10.5	.70	0.73	2.65	2.73	1.25	1.35
Maximum	32.5	24.65	171	120	20.4	18.6	62.2	53.2	33.6	29.6
Minimum	3.70	1.68	.50	.17	.10	.07	.30	.32	0	.01
Percent difference in sum		-33		-22		-19		-5		-13
Total nitrogen										
Sum	75,900	72,900	211,000	200,000	24,100	23,700	77,600	73,000	591	513
Median	314	293	489	413	26.1	22.1	93.3	77.1	1.25	1.35
Maximum	3,710	4,300	13,700	13,100	1,610	1,550	10,600	12,200	33.6	29.6
Minimum	66.5	48.0	13.2	14.3	1.60	1.44	6.70	6.84	0	.01
Percent difference in sum		-4		-5		-2		-6		-13
Soluble phosphorus										
Sum	6,160	6,070	8,110	8,080	998	897	2,260	2,230	2,550	1,830
Median	18.1	16.9	14.1	14.3	2.65	2.32	4.40	3.92	14.1	3.84
Maximum	209	249	356	392	39.0	30.9	107	127	97.5	108
Minimum	3.00	2.85	.40	.46	.30	.65	1.00	1.00	.10	.03
Percent difference in sum		-1		0		-10		-1		-28
Total phosphorus										
Sum	103,000	36,200	64,200	61,300	9,120	8,500	43,700	30,100	23,700	13,300
Median	140	87.7	95.4	101	12.6	11.3	31.9	28.6	15.3	15.3
Maximum	5,990	1,910	3,130	3,160	407	425	6,620	6,180	11,200	2,240
Minimum	12.6	8.38	2.10	1.97	1.40	1.35	4.20	5.00	0	0.09
Percent difference in sum		-65		-5		-7		-31		-44
Biologically reactive iron										
Sum	4,820,000	205,000	646,000	755,000	24,800	30,000	243,000	420,000	143,000	272,000
Median	1,340	1,060	1,010	1,160	34.4	32.5	327	265	60.7	51.7
Maximum	535,000	13,000	30,600	64,700	1,960	3,960	11,500	183,000	24,100	127,000

Table 17. Comparison of monthly load summary statistics (sum, median, maximum, and minimum) and percent difference for load-estimation programs, ESTIMATOR and FLUX, for the 10 primary LTIMP sampling stations, through water year 1998, Lake Tahoe Basin, California and Nevada—Continued

	Trout Creek at South Lake Tahoe		Upper Truckee River at South Lake Tahoe		General Creek near Meeks Bay		Blackwood Creek near Tahoe City		Ward Creek at State Highway 89	
	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)	FLUX (kg)	ESTIMATOR (kg)
Biologically reactive iron										
Minimum	250	190	24.3	27.8	2.30	3.42	37.3	67.6	.10	.18
Percent difference in sum		-96		17		21		73		90
Suspended sediment										
Sum	21,800,000	18,900,000	53,500,000	56,300,000	3,500,000	3,670,000	31,500,000	255,000,000	17,200,000	46,500,000
Median	40,600	24,900	40,900	34,200	785	789	6,010	4,240	3,950	1,750
Maximum	1,130,000	1,380,000	3,670,000	7,950,000	914,000	986,000	6,450,000	207,000,000	4,470,000	37,600,000
Minimum	3,120	432	227	384	54.4	83.8	129	178	15.4	32.2
Percent difference in sum		-13		5		5		710		170

SUMMARY					
Constituent	Range of percent difference	Wilcoxon signed-rank test	Test statistic, Ts	Accept null hypothesis, Ho	Results same/not
Nitrite + nitrate	-39 to 17	24	8	Accept	Same
Dissolved ammonia	-32 to 119	5	8	Reject	Different
Total nitrogen	-13 to -2	0	8	Reject	Different
Soluble phosphorus	-78- to 5	5	8	Reject	Different
Total phosphorus	-65 to -3	0	8	Reject	Different
Biologically reactive iron	-96 to 90	27	8	Accept	Same
Suspended sediment	-33 to 709	25	8	Accept	Same

Dissolved nitrite plus nitrate nitrogen

Estimated monthly loads of dissolved nitrite plus nitrate nitrogen for the study period ranged from 0.01 kilogram per month (kg/mo) at Logan House Creek near Glenbrook and Ward Creek below confluence to 848 kg/mo at Upper Truckee River at South Lake Tahoe. The highest median monthly load was 64.0 kg/mo at Upper Truckee River at South Lake Tahoe and the lowest median was 0.20 kg/mo at Logan House Creek. Dissolved nitrite plus nitrate nitrogen accounted for about 25 percent of the total nitrogen load for all stations.

Dissolved ammonia nitrogen

Estimated monthly loads of dissolved ammonia nitrogen for the study period ranged from 0.01 kg/mo at Logan House Creek, Glenbrook Creek at Glenbrook, Ward Creek at Highway 89 and Ward Creek below confluence to 120 kg/mo at Upper Truckee River at South Lake Tahoe. The highest median monthly load was 10.5 kg/mo at Upper Truckee River at South Lake Tahoe and the lowest median was 0.07 kg/mo at Logan House Creek near Glenbrook. Dissolved ammonia nitrogen accounted for about 7 percent of the total nitrogen load for all stations.

Total nitrogen

Estimated monthly loads of total nitrogen for the study period ranged from 0.07 kg/mo at Logan House Creek near Glenbrook and Ward Creek below confluence to 13,100 kg/mo at Upper Truckee River at South Lake Tahoe. The highest median monthly load was 413 kg/mo at Upper Truckee River at South Lake Tahoe and the lowest median was 2.65 kg/mo at Logan House Creek near Glenbrook.

Soluble reactive phosphorus

Estimated monthly loads of soluble reactive phosphorus for the study period ranged from 0.01 kg/mo at Logan House Creek near Glenbrook and Ward Creek below confluence to 392 kg/mo at Upper Truckee River at South Lake Tahoe. The highest median monthly load was 16.9 kg/mo at Trout Creek at South Lake Tahoe and the lowest median was 0.05 kg/mo at Logan House Creek near Glenbrook. Soluble reactive phosphorus load accounted for about 18 percent of the total phosphorus load for all stations.

Total phosphorus

Estimated monthly loads of total phosphorus for the study period ranged from 0.02 kg/mo at Logan House Creek near Glenbrook to 6,180 kg/mo at Blackwood Creek near Tahoe City. The highest median monthly load was 101 kg/mo at Upper Truckee River at South Lake Tahoe and the lowest median was 0.25 kg/mo at Logan House Creek near Glenbrook.

Biologically reactive iron

Estimated monthly loads of biologically reactive iron for the study period ranged from 0.04 kg/mo at Logan House Creek near Glenbrook to 183,000 kg/mo at Blackwood Creek near Tahoe City. The highest median monthly load was 1,160 kg/mo at Upper Truckee River at South Lake Tahoe and the lowest median was 1.30 kg/mo at Logan House Creek near Glenbrook.

Suspended sediment

Estimated monthly loads of suspended sediment for the study period ranged from 0.1 kg/mo at Logan House Creek near Glenbrook to 6,500,000 kg/mo at Blackwood Creek near Tahoe City. The highest median monthly load was 40,900 kg/mo at Upper Truckee River at South Lake Tahoe and the lowest median was 36.8 kg/mo at Logan House Creek near Glenbrook.

Index station monthly loads

Plots of estimated monthly loads for nutrients and suspended sediment for the two index primary stations, Incline Creek near Crystal Bay and Upper Truckee River at South Lake Tahoe, for various periods of record are shown in figures 17–22. Monthly loads for Incline Creek near Crystal Bay are grouped by nitrogen (fig. 17), phosphorus (fig. 18), and biologically reactive iron and suspended sediment (fig. 19). Upper Truckee River at South Lake Tahoe monthly loads are grouped by nitrogen (fig. 20), phosphorus (fig. 21), and biologically reactive iron and suspended sediment (fig. 22). Median monthly loads for the period of record for these two stations were summarized by months and seasons and also included in figures 17–22.

Table 18. Nutrient and suspended-sediment monthly load summary statistics (median, maximum, and minimum) and median monthly yields for period of comparison (water years 1988–98) and for complete period of record for the 10 primary LTIMP sampling stations in the Lake Tahoe Basin, California and Nevada

[Abbreviations: kg, kilogram; kg/km^2, kilogram per square kilometer; kg/mo; kilogram per month]

	Dissolved nitrite + nitrate (NO_2 + NO_3) nitrogen (kg/mo)	Dissolved ammonia (NH_4) nitrogen (kg/mo)	Total nitrogen (kg/mo)	Soluble reactive phosphorus (kg/mo)	Total phosphorus (kg/mo)	Biologically reactive iron (kg/mo)	Suspended sediment (kg/mo)
Third Creek near Crystal Bay							
Comparison period	1988–98	1988–98	1988–98	1988–98	1988–98	1990–98	1988–98
Median	5.91	1.08	117	3.07	24.2	716	21,200
Maximum	85.7	7.88	1,900	55.2	576	6,980	2,080,000
Minimum	.88	.20	10.3	.64	3.55	97.5	1,840
Yield (kg/km^2)	.38	.07	7.50	.20	1.55	45.9	1,360
Incline Creek near Crystal Bay							
Comparison period	1988–98	1988–98	1988–98	1988–98	1988–98	1990–98	1988–98
Median	9.65	1.46	95.4	5.17	22.9	544	15,700
Maximum	86.4	10.5	1,950	69.4	610	6,410	401,000
Minimum	1.30	.29	15.3	1.03	2.30	76.1	2,200
Yield (kg/km^2)	.56	.08	5.51	.30	1.32	31.4	908
Glenbrook Creek at Glenbrook							
Comparison period	1988–98	1988–98	1988–98	1988–98	1988–98	1990–98	1988–98
Median	.83	.25	12.4	0.74	2.59	64.9	559
Maximum	17.1	3.17	428	18.8	135	1,210	42,700
Minimum	.04	.01	.15	.02	.09	.62	6.2
Yield (kg/km^2)	.08	.02	1.17	.07	.24	6.12	52.7
Logan House Creek near Glenbrook							
Comparison period	1988–98	1988–98	1988–98	1988–98	1988–98	1990–98	1988–98
Median	.20	.07	2.65	.05	.25	1.30	36.8
Maximum	3.49	1.74	125	2.08	14.3	198	13,500
Minimum	.01	.01	.07	.01	.02	.04	.1
Yield (kg/km^2)	.04	.01	.49	.01	.04	.24	6.80
Edgewood Creek at Stateline							
Comparison period	1988–98	1988–98	1988–98	1988–98	1988–98	1990–98	1988–98
Median	5.20	1.72	53.1	3.82	14.6	233	4,450
Maximum	25.8	53.7	425	27.5	166	1,150	30,000

Table 18. Nutrient and suspended-sediment monthly load summary statistics (median, maximum, and minimum) and median monthly yields for period of comparison (water years 1988–98) and for complete period of record for the 10 primary LTIMP sampling stations in the Lake Tahoe Basin, California and Nevada—Continued

	Dissolved nitrite + nitrate ($NO_2 + NO_3$) nitrogen (kg/mo)	Dissolved ammonia (NH_4) nitrogen (kg/mo)	Total nitrogen (kg/mo)	Soluble reactive phosphorus (kg/mo)	Total phosphorus (kg/mo)	Biologically reactive iron (kg/mo)	Suspended sediment (kg/mo)
Edgewood Creek at Stateline							
Minimum	1.31	.11	13.5	1.40	4.30	47.9	631
Yield (kg/km^2)	.36	.12	3.66	.26	1.01	16.1	307
Trout Creek at South Lake Tahoe							
Period of record	1982–98	1988–98	1988–98	1982–98	1982–98	1990–98	1982–98
Median	28.8	5.74	293	16.9	87.7	1,000	40,600
Maximum	188	24.6	4,300	249	1,910	13,000	1,130,000
Minimum	3.23	1.68	48.0	2.85	8.38	123	3,120
Comparison period	1988–98	1988–98	1988–98	1988–98	1988–98	1990–98	1988–98
Median	22.0	5.74	293	13.8	61.9	1,000	23,000
Maximum	119	24.6	4,300	168	860	13,000	820,000
Minimum	3.83	1.68	48.0	3.98	12.41	123	3,120
Yield (kg/km^2)	.21	.05	2.79	.13	.59	9.52	219
Upper Truckee River at South Lake Tahoe							
Period of record	1983–98	1988–98	1988–98	1983–98	1983–98	1983–98	1983–98
Median	64.0	10.5	413	14.3	101	1,160	40,900
Maximum	848	120	13,100	392	3,160	64,700	3,670,000
Minimum	1.08	.17	14.3	.46	1.97	27.8	227
Comparison period	1988–98	1988–98	1988–98	1988–98	1988–98	1990–98	1988–98
Median	53.0	10.5	413	11.1	76.7	1,200	33,200
Maximum	848	120	13,100	392	3,160	64,700	3,670,000
Minimum	1.08	.17	14.3	.46	1.97	27.8	227
Yield (kg/km^2)	.38	.08	2.95	.08	.55	8.57	237
General Creek near Meeks Bay							
Period of record	1985–98	1988–98	1988–98	1985–98	1985–98	1990–98	1985–98
Median	2.32	0.73	22.1	2.32	11.3	32.5	785
Maximum	55.4	18.6	1,550	30.9	425	3,960	914,000
Minimum	.14	.07	1.44	.65	1.35	3.42	54.4

Table 18. Nutrient and suspended-sediment monthly load summary statistics (median, maximum, and minimum) and median monthly yields for period of comparison (water years 1988–98) and for complete period of record for the 10 primary LTIMP sampling stations in the Lake Tahoe Basin, California and Nevada—Continued

	Dissolved nitrite + nitrate ($NO_2 + NO_3$) nitrogen (kg/mo)	Dissolved ammonia (NH_4) nitrogen (kg/mo)	Total nitrogen (kg/mo)	Soluble reactive phosphorus (kg/mo)	Total phosphorus (kg/mo)	Biologically reactive iron (kg/mo)	Suspended sediment (kg/mo)
General Creek near Meeks Bay							
Comparison period	1988–98	1988–98	1988–98	1988–98	1988–98	1990–98	1988–98
Median	1.58	0.73	22.1	2.10	9.74	32.5	576
Maximum	43.5	18.6	1,550	30.9	425	3,960	914,000
Minimum	0.14	0.07	1.44	0.65	1.35	3.42	54.4
Yield (kg/km^2)	.08	.04	1.16	.11	.51	1.70	30.2
Blackwood Creek near Tahoe City							
Period of record	1986–98	1988–98	1988–98	1986–98	1986–98	1986–98	1986–98
Median	12.4	2.73	77.1	3.92	28.6	265	6,000
Maximum	783	53.2	12,200	127	6,180	183,000	6,500,000
Minimum	.43s	.32	6.84	1.00	5.00	67.6	129
Comparison period	1988–98	1988–98	1988–98	1988–98	1988–98	1990–98	1988–98
Median	11.4	2.73	77.1	3.83	28.6	316	6,820
Maximum	783	53.2	12,200	127	6,180	183,000	6,500,000
Minimum	.43	.32	6.84	1.00	5.00	84.6	129
Yield (kg/km^2)	.40	.10	2.69	.13	1.00	11.0	238
Ward Creek at State Highway 89							
Period of record	1986–98	1988–98	1988–98	1986–98	1986–98	1986–98	1986–98
Median	3.66	1.35	48.8	3.84	15.3	51.7	3,950
Maximum	608	29.6	5,540	108	2,240	127,000	4,470,000
Minimum	.02	.01	.23	.03	.09	.18	32.2
Comparison period	1988–98	1988–98	1988–98	1988–98	1988–98	1990–98	1988–98
Median	3.82	1.35	48.8	3.88	15.8	71.5	4,160
Maximum	608	29.6	5,540	108	2,240	127,000	4,470,000
Minimum	.02	.01	.23	.03	.09	.30	15.4
Yield (kg/km^2)	.15	.05	1.94	.15	.63	2.84	165

Table 19. Nutrient and suspended-sediment monthly load and runoff summary statistics (sum, median, minimum, and maximum), percent change in sums between stations, and monthly median units/yields between stations for period of comparison (water years 1991–98) for three LTIMP sampling stations in the Incline Creek watershed, in the Incline Village area, Lake Tahoe Basin, Nevada

[Abbreviations: acre-ft, acre-feet; acre-ft/ mi^2, acre-feet per square mile; kg, kilogram; kg/km^2, kilogram per square kilometer; kg/mo., kilogram per month. Symbol: —, not applicable]

	Average annual runoff (acre-ft)	Dissolved nitrite + nitrate (NO_2 + NO_3) nitrogen (kg/mo)	Dissolved ammonia (NH_4) nitrogen (kg/mo)	Total nitrogen (kg/mo)	Soluble reactive phosphorus (kg/mo)	Total phosphorus (kg/mo)	Biologically reactive iron (kg/mo)	Suspended sediment (kg/mo)
Incline Creek near Crystal Bay								
Sum	—	1,960	206	23,900	1,040	6,500	99,400	4,370,000
Median	6,220 (average)	10.8	1.46	117	7.12	30.9	558	20,200
Maximum	—	86.4	10.5	1,950	69.4	610	6,410	401,000
Minimum	—	1.30	.28	16.2	1.03	3.96	76.1	2,200
Percent change in sum	24	39	23	52	34	43	44	41
Yield (kg/km^2)	—	.62	.08	6.76	.41	1.79	32.2	2,710
Unit runoff (acre-ft/mi^2)	930	—	—		—	—	—	—
Incline Creek at Highway 28								
Sum	—	1,200	159	11,600	689	3,680	55,500	2,590,000
Median	4,730 (average)	6.19	1.05	58.2	4.13	19.8	321	15,400
Maximum	—	55.0	8.17	833	41.2	278	3,210	142,000
Minimum	—	.91	.19	6.89	.54	2.29	44.1	2,730
Percent change in sum	22	21	49	17	31	32	39	36
Yield (kg/km^2)	—	.52	.09	4.93	.35	1.68	27.2	1,310
Unit runoff (acre-ft/mi^2)	1,040	—	—	—	—	—	—	—
Incline Creek above Tyrol Village								
Sum	—	776	57.5	7,470	364	1,620	16,300	1,003,000
Median	3,370 (average)	4.53	.31	38.0	2.25	7.66	56.0	1,900
Maximum	—	48.3	3.34	630	23.2	152	1,840	168,000
Minimum	—	.17	.08	2.51	.26	.92	4.56	94.5
Percent change in sum	54	40	28	31	35	25	17	23
Yield (kg/km^2)	—	.61	.04	5.15	.30	1.04	4.75	257
Unit runoff (acre-ft/mi^2)	1,180	—	—	—	—	—	—	—

Table 20. Nutrient and suspended-sediment monthly load and runoff summary statistics (sum, median, minimum, and maximum), percent change in sums between stations, and monthly median units/yields between stations for period of comparison (water years 1992–98) and complete period of record for three LTIMP sampling stations in the Edgewood Creek watershed, in the Stateline area, Lake Tahoe Basin, Nevada

[Abbreviations: acre-ft, acre-feet; kg, kilogram; kg/km^2, kilogram per square kilometer; acre-ft/ mi^2, acre-feet per square mile; kg/mo., kilogram per month. Symbol: —, not applicable]

	Average annual runoff (acre-ft)	Dissolved nitrite + nitrate (NO_2 + NO_3) nitrogen (kg/mo)	Dissolved ammonia (NH_4) nitrogen (kg/mo)	Total nitrogen (kg/mo)	Soluble reactive phosphorus (kg/mo)	Total phosphorus (kg/mo)	Biologically reactive iron (kg/mo)	Suspended sediment (kg/mo)
Edgewood Creek at Stateline								
Sum	—	538	294	6,270	342	1,520	23,300	431,000
Median	3,480 (average)	5.20	1.72	53.1	3.82	14.6	233	4,450
Maximum	—	25.8	53.7	425	27.5	166	1,150	30,000
Minimum	—	1.31	.11	13.5	1.40	4.30	47.9	631
Percent change in sum	53	59	90	36	56	40	37	-52
Yield (kg/km^2)	—	.36	.12	3.66	.26	1.01	16.1	307
Unit runoff (acre-ft/mi^2)	620	—	—	—	—	—	—	—
Edgewood Creek at Palisade Dr.								
Comparison period:								
Sum	—	171	20.0	3,080	97.7	719	13,100	850,000
Median	1,080 (average)	1.41	.23	25.1	1.08	5.21	105	9,740
Maximum	—	8.12	.89	254	5.75	83.0	894	87,700
Minimum	—	.08	.03	.84	.12	.50	5.56	163
Percent input	31	32	7	49	29	47	56	94
Yield (kg/km^2)	—	.17	.03	3.09	.13	.64	12.9	1,200
Unit runoff (acre-ft/mi^2)	345	—	—	—	—	—	—	—
Period of record:								
Median	—	1.16	.19	17.3	.54	3.25	72.9	5,300
Maximum	—	8.12	.89	254	5.75	83.0	894	87,700
Minimum	—	.08	.03	.84	.12	.50	5.56	163
Eagle Rock Creek near Stateline								
Comparison period:								
Sum	—	51.1	9.58	965	53.1	193	1,700	52,000
Median	565 (average)	.55	.12	13.0	.78	2.75	23.1	711
Maximum	—	2.09	.31	40.8	1.88	7.21	64.9	3,420
Minimum	—	.09	.02	2.44	.19	.51	4.30	30.7
Percent input	16	9	3	15	15	13	7	6

Table 20. Nutrient and suspended-sediment monthly load and runoff summary statistics (sum, median, minimum, and maximum), percent change in sums between stations, and monthly median units/yields between stations for period of comparison (water years 1992–98) and complete period of record for three LTIMP sampling stations in the Edgewood Creek watershed, in the Stateline area, Lake Tahoe Basin, Nevada—Continued

	Average annual runoff (acre-ft)	Dissolved nitrite + nitrate (NO_2 + NO_3) nitrogen (kg/mo)	Dissolved ammonia (NH_4) nitrogen (kg/mo)	Total nitrogen (kg/mo)	Soluble reactive phosphorus (kg/mo)	Total phosphorus (kg/mo)	Biologically reactive iron (kg/mo)	Suspended sediment (kg/mo)
				Eagle Rock Creek near Stateline				
Yield (kg/km^2)	—	0.34	0.07	7.98	0.48	1.69	14.2	436
Unit runoff (acre-ft/mi^2)	897	—	—	—	—	—	—	—
Period of record:								
Median	—	.51	.10	7.33	.35	2.48	12.4	225
Maximum	—	2.09	.31	40.8	1.88	7.21	64.9	3,420
Minimum	—	.09	.02	1.91	.18	.51	3.55	30.7

Table 21. Nutrient and suspended-sediment monthly load and runoff summary statistics (sum, median, minimum, and maximum), percent change in sums between stations, and monthly median units/yields between stations for period of comparison (water years 1991–98) and complete period of record for three LTIMP sampling stations in the Trout Creek watershed, South Lake Tahoe area, Lake Tahoe Basin, Nevada

[Abbreviations: acre-ft, acre-feet; kg, kilogram; kg/km^2, kilogram per square kilometer; kg/mo., kilogram per month; acre-ft/ mi^2, acre-feet per square mile. Symbol: —, not applicable. Average annual runoff for Trout Creek at South Lake Tahoe is taken from Trout Creek near Tahoe Valley, upstream]

	Average annual runoff (acre-ft)	Dissolved nitrite + nitrate (NO_2 + NO_3) nitrogen (kg/mo)	Dissolved ammonia (NH_4) nitrogen (kg/mo)	Total nitrogen (kg/mo)	Soluble reactive phosphorus (kg/mo)	Total phosphorus (kg/mo)	Biologically reactive iron (kg/mo)	Suspended sediment (kg/mo)
Trout Creek at South Lake Tahoe								
Sum	—	2,890	656	65,900	2,770	13,800	201,000	10,300,000
Median	27,300 (average)	23.2	4.92	324	15.4	65.2	1,060	35,200
Maximum	—	119	21.4	4,300	168	860	13,000	820,000
Minimum	—	4.16	1.68	62.7	4.26	12.75	190	4,480
Percent change in sum	29	47	56	40	37	41	44	56
Yield (kg/km^2)	—	.22	.05	3.09	.15	.62	10.1	335
Unit runoff (acre-ft/mi^2)	744	—	—	—	—	—	—	—
Trout Creek at Pioneer Trail								
Sum	—	1,520	287	39,900	1,750	8,170	112,000	4,680,000
Median	19,400 (average)	8.84	1.68	163	9.78	31.1	350	7,900
Maximum	—	72.4	13.2	3,100	107	728	11,300	572,000
Minimum	—	1.09	.58	30.1	2.93	8.48	78.0	500
Percent change in sum	39	37	25	37	38	39	41	45
Yield (kg/km^2)	—	.15	.03	2.73	.16	.52	5.85	132
Unit runoff (acre-ft/mi^2)	840	—	—	—	—	—	—	—
Trout Creek at U.S. Forest Service Rd. 12N01								
Sum		464	121	15,300	709	2,800	29,700	2,000,000
Median	8,690 (average)	2.77	.71	54.1	4.40	10.8	62.0	2,700
Maximum	—	26.0	7.05	1,590	43.7	335	4,630	391,000
Minimum	—	1.09	.28	16.3	1.53	4.22	17.6	279
Percent change in sum	32	16	19	23	25	20	15	19
Yield (kg/km^2)	—	.14	.04	2.82	.23	.56	3.23	141
Unit runoff (acre-ft/mi^2)	744	—	—	—	—	—	—	—

Table 22. Nutrient and suspended-sediment monthly load and runoff summary statistics (sum, median, minimum, and maximum), percent change in sums between stations, and monthly median units/yields between stations for period of comparison (water years 1991–98) for three LTIMP sampling stations in the Upper Truckee River watershed, South Lake Tahoe area, Lake Tahoe Basin, Nevada

[Abbreviations: acre-ft, acre-feet; kg, kilogram; kg/km^2, kilogram per square kilometer; kg/mo., kilogram per month; acre-ft/ mi^2, acre-feet per square mile; —, not applicable]

	Average annual runoff (acre-ft)	Dissolved nitrite + nitrate (NO_2 + NO_3) nitrogen (kg/mo)	Dissolved ammonia (NH_4) nitrogen (kg/mo)	Total nitrogen (kg/mo)	Soluble reactive phosphorus (kg/mo)	Total phosphorus (kg/mo)	Biologically reactive iron (kg/mo)	Suspended sediment (kg/mo)
Upper Truckee River at South Lake Tahoe								
Sum	—	11,800	2,100	173,000	4,860	34,700	515,000	35,200,000
Median	74,200 (average)	53.0	10.0	565	16.8	94.8	1,280	55,100
Maximum	—	848	108	13,100	392	3,160	64,700	7,670,000
Minimum	—	1.08	.17	14.3	.46	1.97	27.8	227
Percent change in sum	12	37	48	39	42	47	60	68
Yield (kg/km^2)	—	.38	.07	4.04	.12	.68	9.14	394
Unit runoff (acre-ft/mi^2)	1,370	—	—	—	—	—	—	—
Upper Truckee River at Highway 50 above Meyers								
Sum	—	7,470	1,090	106,000	2,840	18,300	206,000	11,300,000
Median	65,400 (average)	27.2	3.86	282	10.1	45.3	462	12,300
Maximum	—	503	83.2	10,000	261	2,070	22,000	1,550,000
Minimum	—	1.41	.25	16.4	1.00	3.58	35.3	153
Percent change in sum	49	41	31	39	18	29	27	24
Yield (kg/km^2)	—	.27	.04	2.76	.10	.44	4.53	121
Unit runoff (acre-ft/mi^2)	1,660	—	—	—	—	—	—	—
Upper Truckee River at South Upper Truckee Road								
Sum	—	2,630	441	38,900	1,940	8,390	68,900	2,730,000
Median	29,200 (average)	11.6	1.63	105	7.00	19.0	131	2,510
Maximum	—	168	44.6	3,350	152	896	7,340	352,000
Minimum	—	1.83	.14	8.63	1.45	3.66	12.0	97.2
Percent change in sum	39	22	21	22	40	24	13	8
Yield (kg/km^2)	—	.32	.04	2.85	.19	.52	3.56	68.2
Unit runoff (acre-ft/mi^2)	2,060	—	—	—	—	—	—	—

Table 23. Nutrient and suspended-sediment monthly load and runoff summary statistics (sum, median, minimum, and maximum), percent change in sums between stations, and monthly median units/yields between stations for period of comparison (water years 1992–98) for three LTIMP sampling stations in the Ward Creek watershed, Tahoe City and Meeks Bay area, Lake Tahoe Basin, Nevada

[Abbreviations: acre-ft, acre-feet; kg, kilogram; kg/km^2, kilogram per square kilometer; kg/mo., kilogram per month; acre-ft/ mi^2, acre-feet per square mile; —, not applicable]

	Average annual runoff (acre-ft)	Dissolved nitrite + nitrate (NO_2 + NO_3) nitrogen (kg/mo.)	Dissolved ammonia (NH_4) nitrogen (kg/mo.)	Total nitrogen (kg/mo.)	Soluble reactive phosphorus (kg/mo.)	Total phosphorus (kg/mo.)	Biologically reactive iron (kg/mo.)	Suspended sediment (kg/mo.)
Ward Creek at State Highway 89								
Sum	—	2,890	335	36,900	1,350	11,000	260,000	16,000,000
Median	22,100 (average)	5.46	1.26	77.5	5.03	21.7	122	7,130
Maximum	—	608	25.5	5,540	108	2,240	127,000	4,470,000
Minimum	—	.02	.01	.23	.03	.09	.30	20.9
Percent change in sum	5	17	-3	12	9	11	40	56
Yield (kg/km^2)	—	.22	.05	3.08	.20	.86	4.84	290
Unit runoff (acre-ft/mi^2)	2,270	—	—	—	—	—	—	—
Ward Creek at Stanford Rock Crossing								
Sum	—	2,410	347	32,600	1,220	9,810	155,000	7,030,000
Median	21,000 (average)	7.07	1.75	65.0	4.48	16.4	120	10,800
Maximum	—	217	23.8	4,730	92.2	2,160	81,800	614,000
Minimum	—	.12	.08	1.76	.51	1.33	12.6	387
Percent change in sum	35	8	30	46	48	44	41	19
Yield (kg/km^2)	—	.30	.08	2.80	.19	.71	5.17	466
Unit runoff (acre-ft/mi^2)	2,340	—	—	—	—	—	—	—
Ward Creek below confluence								
Sum	—	2,170	242	15,600	577	4,970	48,400	3,970,000
Median	13,200 (average)	6.39	1.04	34.5	1.94	8.78	28.3	5,500
Maximum	—	196	19.1	1,410	46.1	558	16,400	521,000
Minimum	—	.01	.01	.07	.01	.03	.05	206
Percent change in sum	60	75	70	42	43	45	19	25
Yield (kg/km^2)	—	.50	.08	2.70	.15	.69	2.21	430
Unit runoff (acre-ft/mi^2)	2,660	—	—	—	—	—	—	—

Incline Creek near Crystal Bay

The monthly load plots for Incline Creek near Crystal Bay (figs. 17–19) show a pattern typical for the smaller streams (drainage area less than 8 mi^2) in the basin. Loads during water years with below-normal precipitation (1988–92 and 1994) generally were low, whereas loads for water years of above-normal precipitation (1993 and 1995–98) were higher. The highest monthly load at this medium-smaller watershed station occurred in spring of 1995 for all nutrients and sediment except dissolved nitrite plus nitrate and ammonia nitrogen. Dissolved nitrite plus nitrate nitrogen had the highest monthly load in the spring (June) of 1996. Dissolved ammonia nitrogen had the highest monthly load in spring (June) of 1998. The highest monthly load for the non-spring period all occurred during January 1997 for all nutrients and suspended sediment.

The seasonal load plots for Incline Creek near Crystal Bay (figs. 17–19) show the highest median seasonal loads for this station occur in the spring during periods of snowmelt. The highest median monthly loads occurred in April for dissolved nitrite plus nitrate nitrogen, soluble reactive phosphorus, and total phosphorus; May for dissolved ammonia nitrogen, total nitrogen, and suspended-sediment; and June for iron. The lowest median seasonal loads occurred during the summer period (July, August and September) for nitrite plus nitrate, soluble reactive phosphorus and total phosphorus; and the fall period (October, November, and December) for ammonia, total nitrogen, iron, and suspended sediment. The lowest median monthly loads occurred in various months but usually in October.

Upper Truckee River at South Lake Tahoe

The monthly load plots for Upper Truckee River at South Lake Tahoe (figs. 20–22) show a pattern typical for larger streams (greater than drainage area of 10 mi^2) in the basin. Loads for water years with below-normal precipitation years (1985, 1987–92, and 1994) generally were low, whereas loads for water years of above-normal precipitation (1984, 1986, 1993, and 1995–98) were much higher. The largest monthly load for this larger watershed station occurred in January of 1997 for all nutrients and sediment except ammonia, which occurred in April 1989.

The seasonal load plots for Upper Truckee River at South Lake Tahoe (figs. 20–22) show the highest median seasonal loads for all nutrient and suspended-sediment constituents occurred in the spring (April, May, and June) during periods of snowmelt. March also had high loads when snowmelt begins. For all constituents, the largest median monthly loads occurred in May and the lowest median seasonal loads occurred during the summer period (July, August and September). The lowest median monthly loads occurred in various months but usually in August, September, or October.

Watershed-Load Comparison

The period of comparison is 1988–98, except Edgewood Creek at Stateline, which was sampled only from 1992 to 1998 after this station was relocated in 1992. The original station, Edgewood Creek at Lake Tahoe, was located about 0.5 mi downstream and was in operation from 1989 to 1992. Because streamflow at Edgewood Creek at Lake Tahoe was affected by various diversions upstream and impoundments downstream, the stage-streamflow relation was determined to be of poor quality. Although samples were collected from this discontinued gaging station, estimated loads were not calculated due to the poor streamflow record. Median monthly loads for nutrients and suspended sediment for the 10 primary stations for the comparison period are shown in figures 23–29.

The Upper Truckee River at South Lake Tahoe had the largest median monthly loads for five of the six nutrients with 53.0 kg/mo nitrite plus nitrate; 10.5 kg/mo ammonia; 413 kg/mo total nitrogen; 76.7 kg/mo total phosphorus; 1,200 kg/mo biologically reactive iron; and 40,900 kg/mo suspended sediment. Trout Creek at South Lake Tahoe had the largest median of monthly loads for soluble reactive phosphorus at 13.8 kg/mo. Logan House Creek near Glenbrook had the smallest median monthly loads for all nutrients and suspended sediment with 0.20 kg/mo dissolved nitrite plus nitrate, 0.07 kg/mo dissolved ammonia, 2.63 kg/mo total nitrogen, 0.05 kg/mo soluble reactive phosphorus, 0.25 kg/mo total phosphorus, 1.30 kg/mo biologically reactive iron, and 36.8 kg/mo suspended sediment.

Within-Watershed Station Load Comparisons

The within-watershed comparison of summary statistics (sum, median, maximum and minimum), percent input of estimated monthly loads of nutrients and suspended sediment and percent differences in sums between 10 secondary stations the period of comparison for stations, by area, are listed in tables 19–24. The

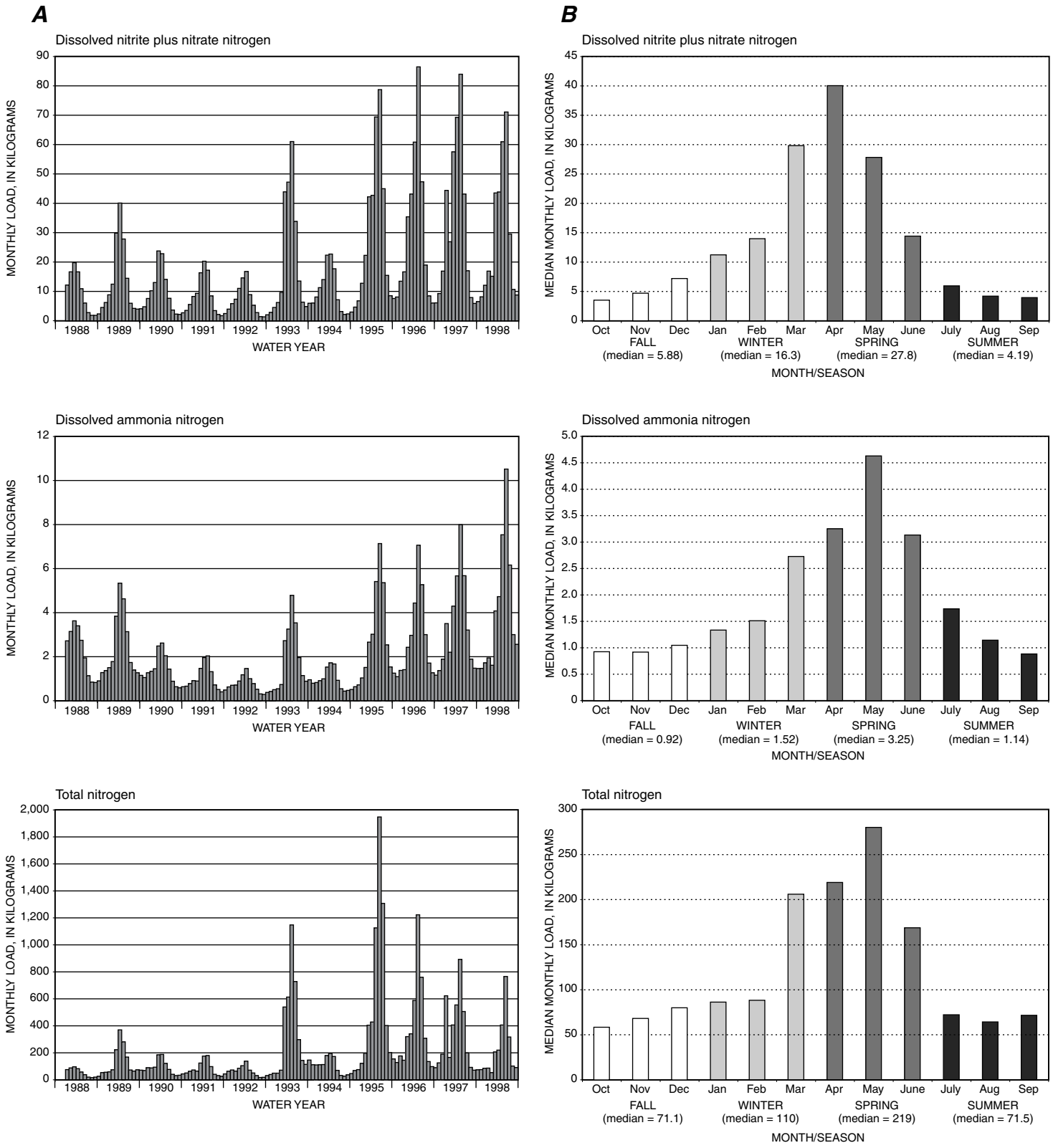

Figure 17. Plots of nitrogen nutrients for Incline Creek near Crystal Bay for water years 1988–98: (*A*) monthly loads, and (*B)* loads by month and season with seasonal medians.

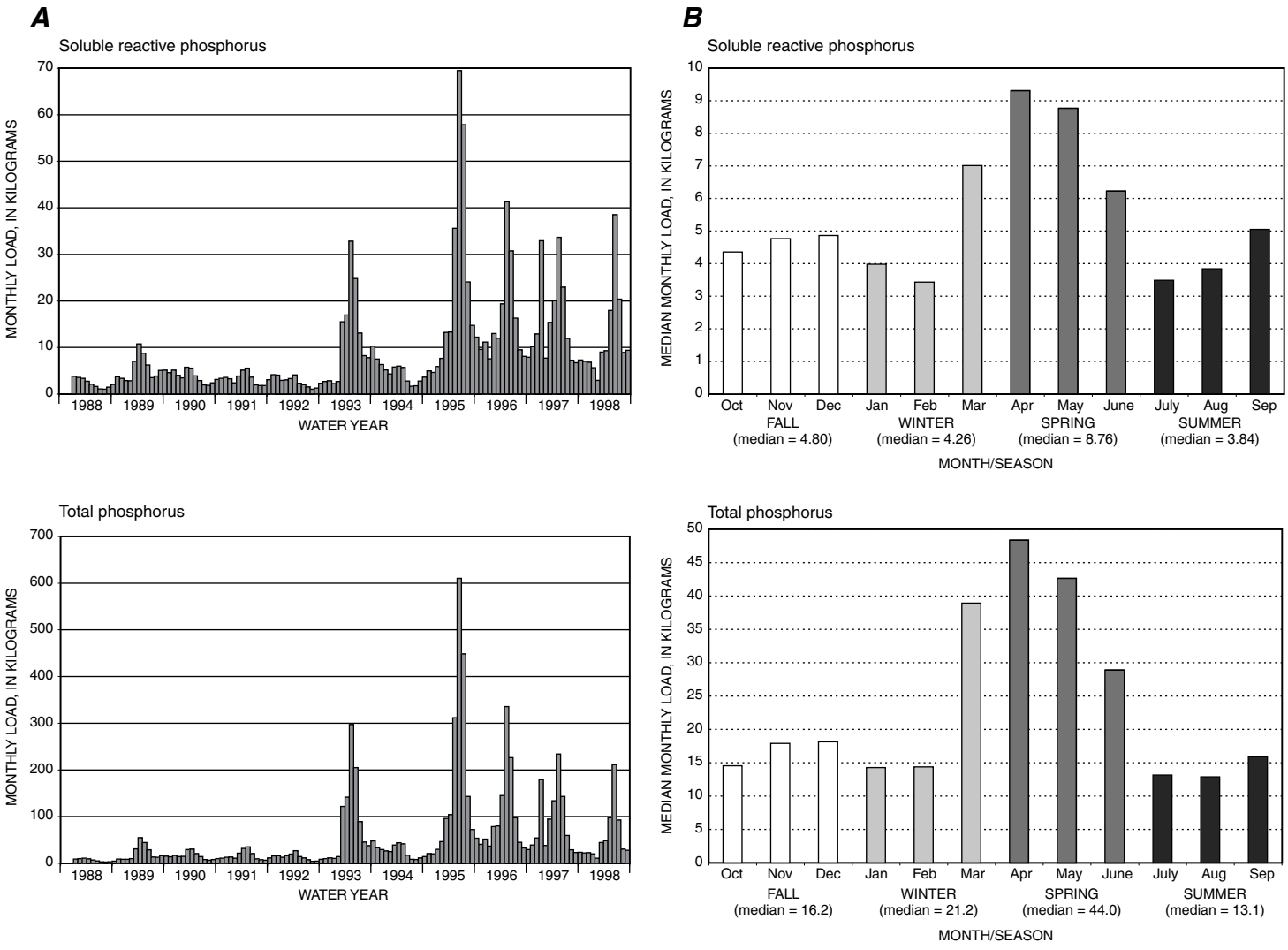

Figure 18. Plots of phosphorus nutrients for Incline Creek near Crystal Bay for water years 1988–98: (*A*) monthly loads, and (*B)* loads by month and season with seasonal medians.

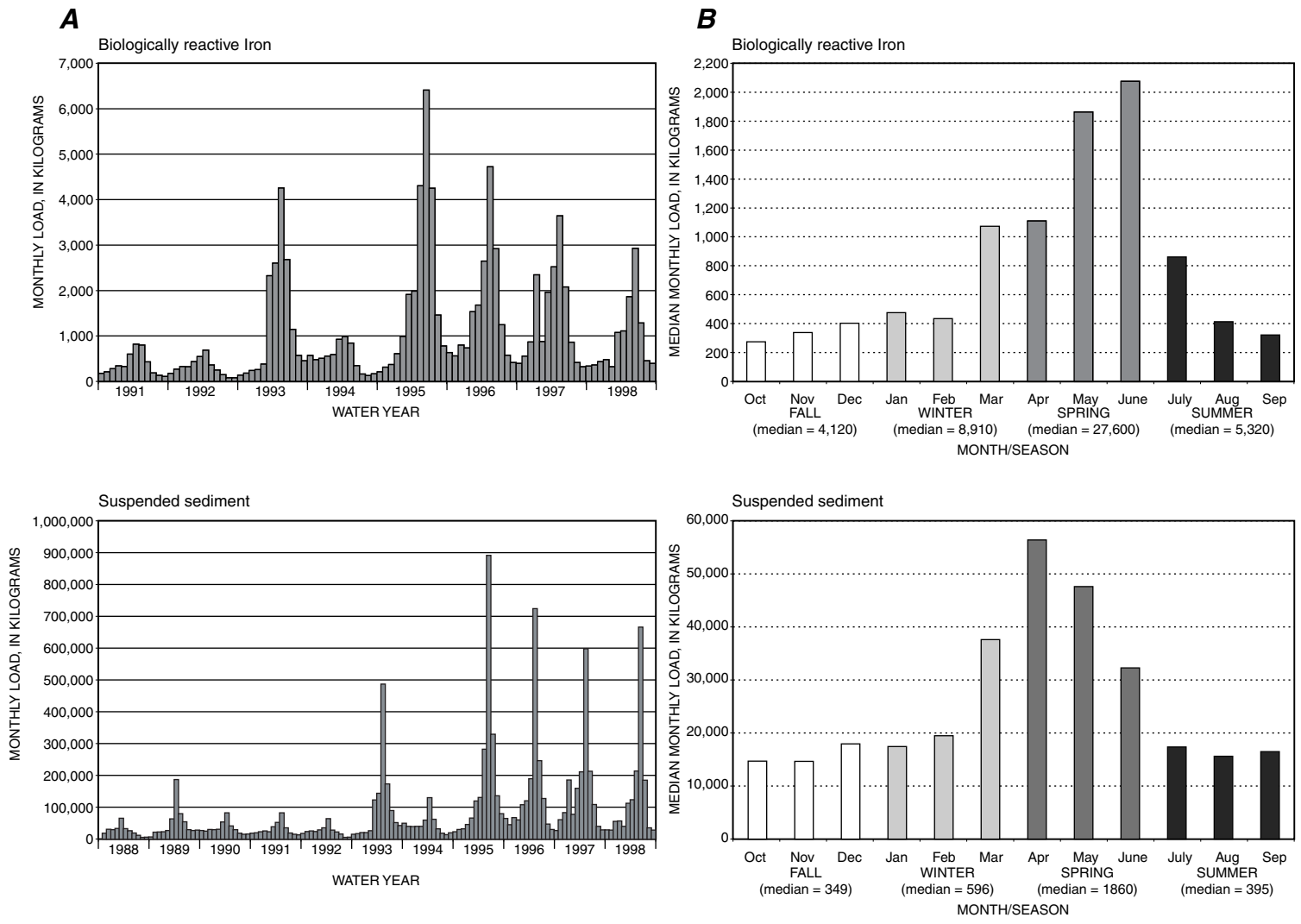

Figure 19. Plots of biologically reactive iron and suspended-sediment concentrations for Incline Creek near Crystal Bay for water years 1991–98 and 1988–98, respectively: (*A*) monthly loads, and (*B)* loads by month and season with seasonal medians.

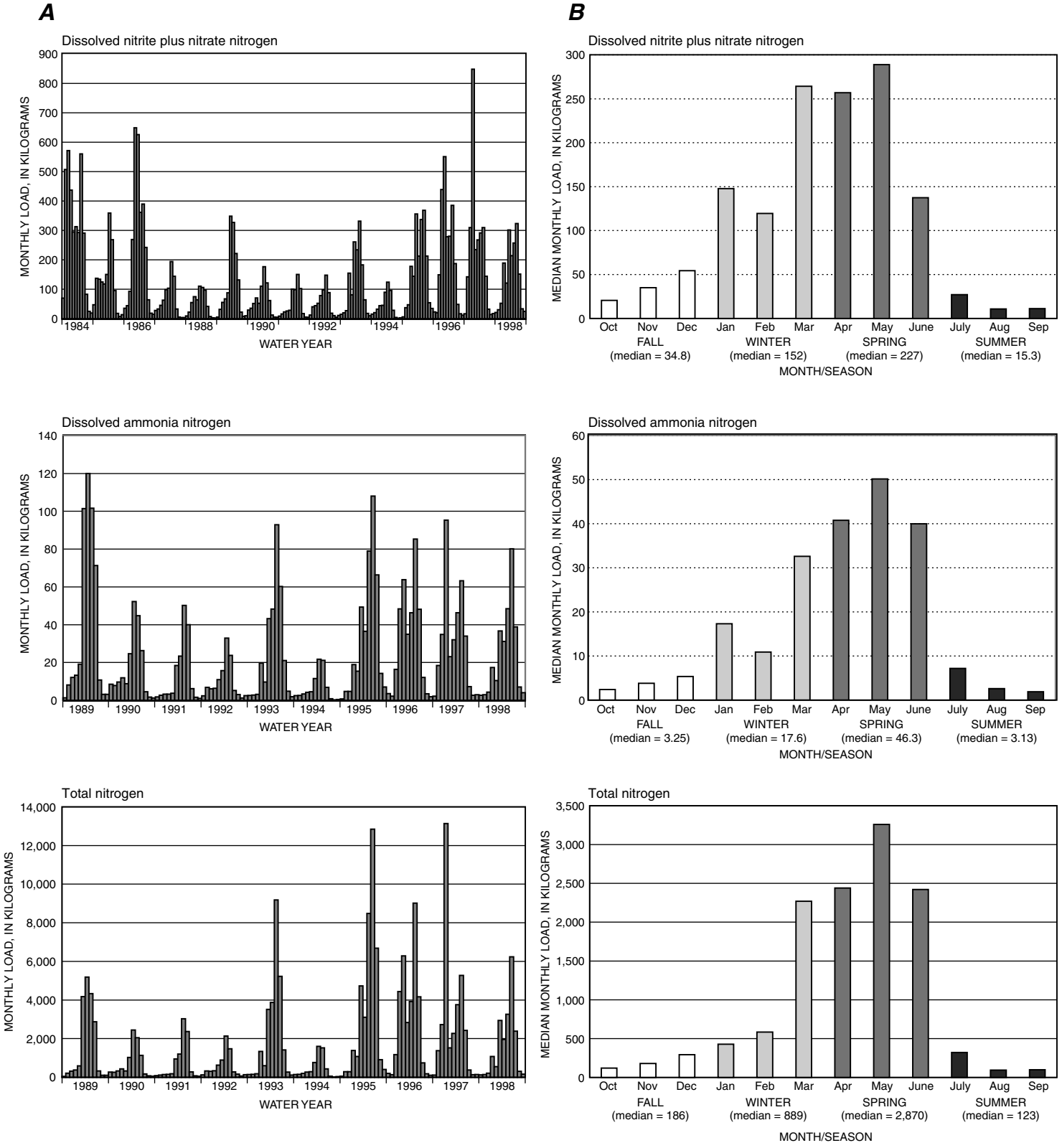

Figure 20. Plots of nitrogen nutrients for Upper Truckee River at South Lake Tahoe for water years 1984–98 and 1989–98: (*A*) monthly loads, and (*B*) loads by month and season with seasonal medians.

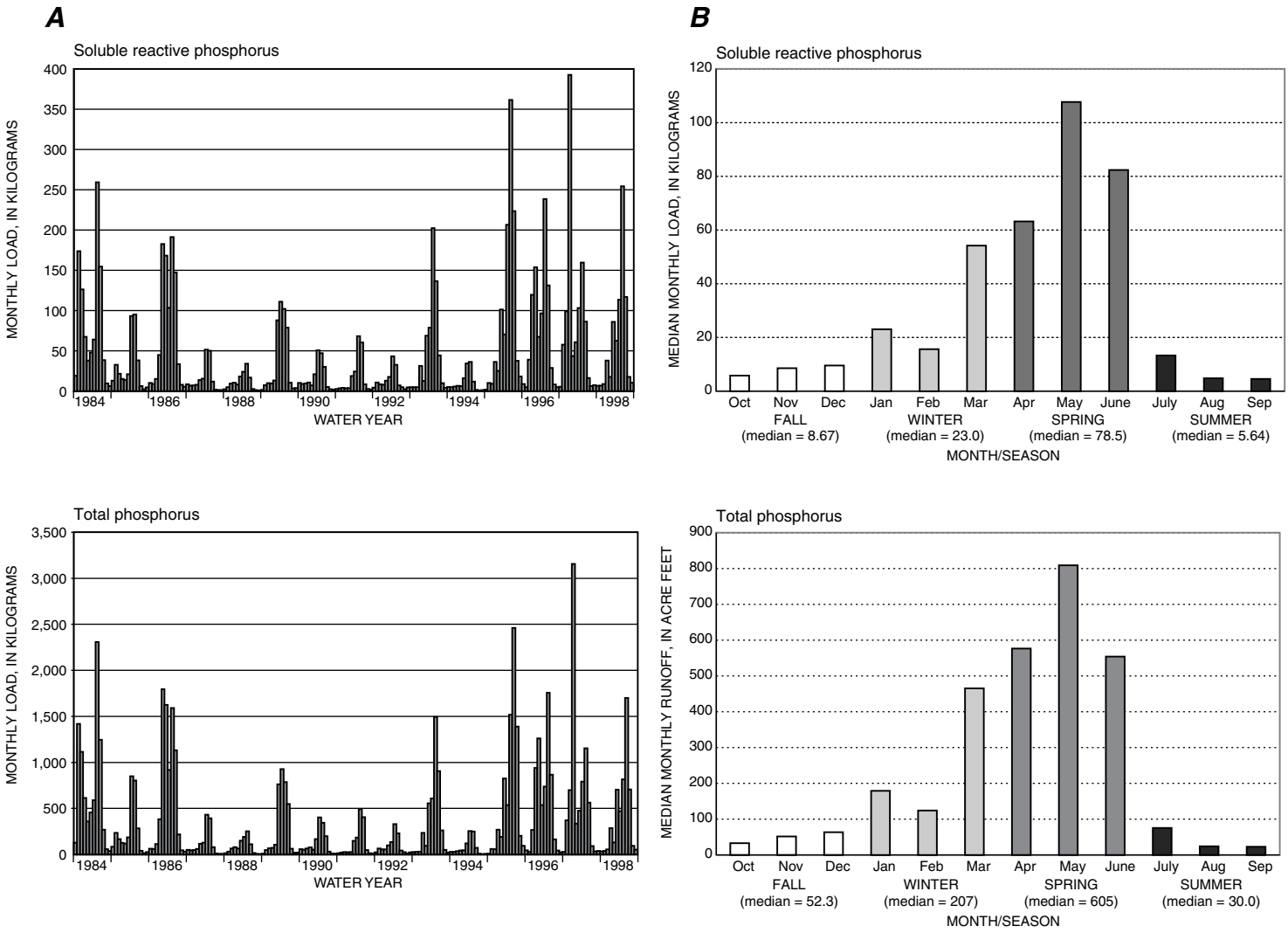

Figure 21. Plots of phosphorus nutrients for Upper Truckee River at South Lake Tahoe for water years 1984–98, : (*A*) monthly loads, and (*B*) loads by month and season with seasonal medians.

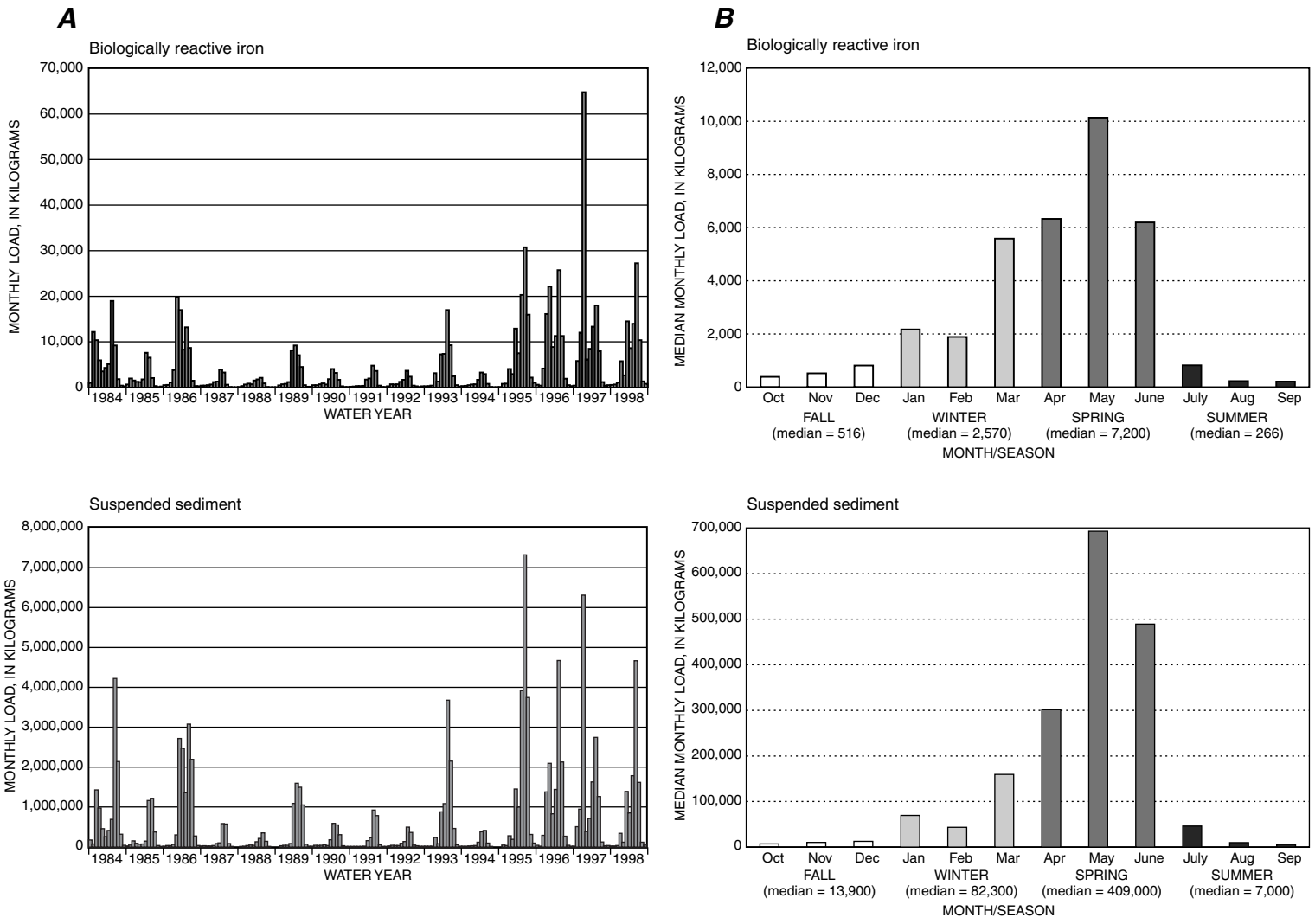

Figure 22. Plots of biologically reactive iron and suspended-sediment concentrations for Upper Truckee River at South Lake Tahoe for water years 1984–98: (*A*) monthly loads, and (*B*) loads by month and season with seasonal medians.

five watersheds that are compared are Incline Creek, Trout Creek, and Upper Truckee River, 1990–98; and Edgewood Creek and Ward Creek, 1992–98.

For each watershed, summary statistics were calculated for runoff and constituent loads using methods described in Helsel and Hirsch (1992). Median values were chosen as preferable summary statistics because they are not strongly influenced by extreme values. For the within-watershed comparison for the five multiple-station watersheds (Incline, Edgewood, Trout and Ward Creeks and Upper Truckee River), monthly loads were compared among stations. Each multiple-station watershed was measured at no less than three points: an upstream station in the headwaters, a middle station between the headwaters and the mouth, and a downstream station at or near the mouth of the stream. For each watershed, the monthly load for the upstream station was considered an "input" amount. The differences in monthly loads between the upstream/middle and middle/downstream stations were then calculated. These values were divided the downstream station load to calculate the percent monthly load contributed by the reach in question. Where more than one station was measured in the headwaters part of the watershed, all headwater stations were totaled as the upstream input.

Monthly nutrient and suspended load plots and the hydrograph for the comparison period (1991–98) for the two index watersheds (Incline Creek and Upper Truckee River) are shown in figures 30 and 31. The three Incline Creek watershed stations (near mouth = near Crystal Bay, middle = at Highway 28, and upstream = above Tyrol Village) are shown in figure 29 and the three Upper Truckee River watershed stations (near mouth = at South Lake Tahoe, middle = above Meyers, and upstream = at South Upper Truckee Road) are shown in figure 31.

The upper Ward Creek watershed station (below confluence) had largest inputs, in terms of percentage, from the upstream watershed area for runoff (60 percent of the total watershed runoff comes from above this station), nitrite plus nitrate (75 percent), ammonia (70 percent) and soluble reactive phosphorus (43 percent). Edgewood Creek at Palisade Drive had largest inputs, in terms of percentage, for total nitrogen (49 percent), total phosphorus (47 percent), iron (56 percent) and suspended sediment (91 percent). The station with the largest average input percentage for all eight constituents was Ward Creek below confluence at 46 percent. The station with the lowest average input percentage for all eight constituents was Eagle Rock Creek (the other Edgewood Creek watershed input station) at 11 percent. The upstream Edgewood Creek watershed stations are not in direct sequence and both are considered "input" stations, so were included in an upstream/downstream station comparison. Edgewood Creek at Stateline station did not show increases from the combined two upstream "input" stations, except with suspended sediment. A portion of the suspended-sediment load in the Edgewood Creek watershed may be stored in a pond upstream of Edgewood Creek at Stateline station.

A summary of average percent changes of sums for the five multiple-station watersheds is listed in table 24. Four of the multiple-station watersheds showed increases in average percent gains going downstream, between the upstream "input" and middle station and the middle and downstream "near mouth" stations. Ward Creek watershed had decreasing percent gains going downstream, with the largest average percent gain coming from above the upstream station. The largest increase between the upstream (input) and middle stations occurred in Trout Creek watershed at 36 percent. The largest increase between the middle and downstream (near mouth) stations occurred in Upper Truckee River watershed at 42 percent. Two watersheds had losses (minus percent) between stations for two constituents. Edgewood Creek watershed had a -34 percent change in suspended sediment between the downstream and two combined upstream stations (table 20). Ward Creek watershed had a -3 percent change in dissolved ammonia between middle and downstream stations (table 23); this may be due to the presence of beaver dams between the stations.

Tables of monthly and daily load estimation values, along with statistical estimates (SE, SE PRED, and 95-percent confidence intervals), for periods of record for the 20 primary and secondary stations are presented in appendix 2.

Yields and Ranks

Median monthly yields, in kilograms per square kilometers per month (kg/km^2/mo), were calculated by dividing median monthly loads by drainage area, in square kilometers. The resulting yields were compared and ranked for each constituent for each of the 10 sampled watersheds. Median monthly yields for each constituent were assigned a rank 1 for the highest yield to a rank 10 for the lowest yield. Overall ranks were deter-

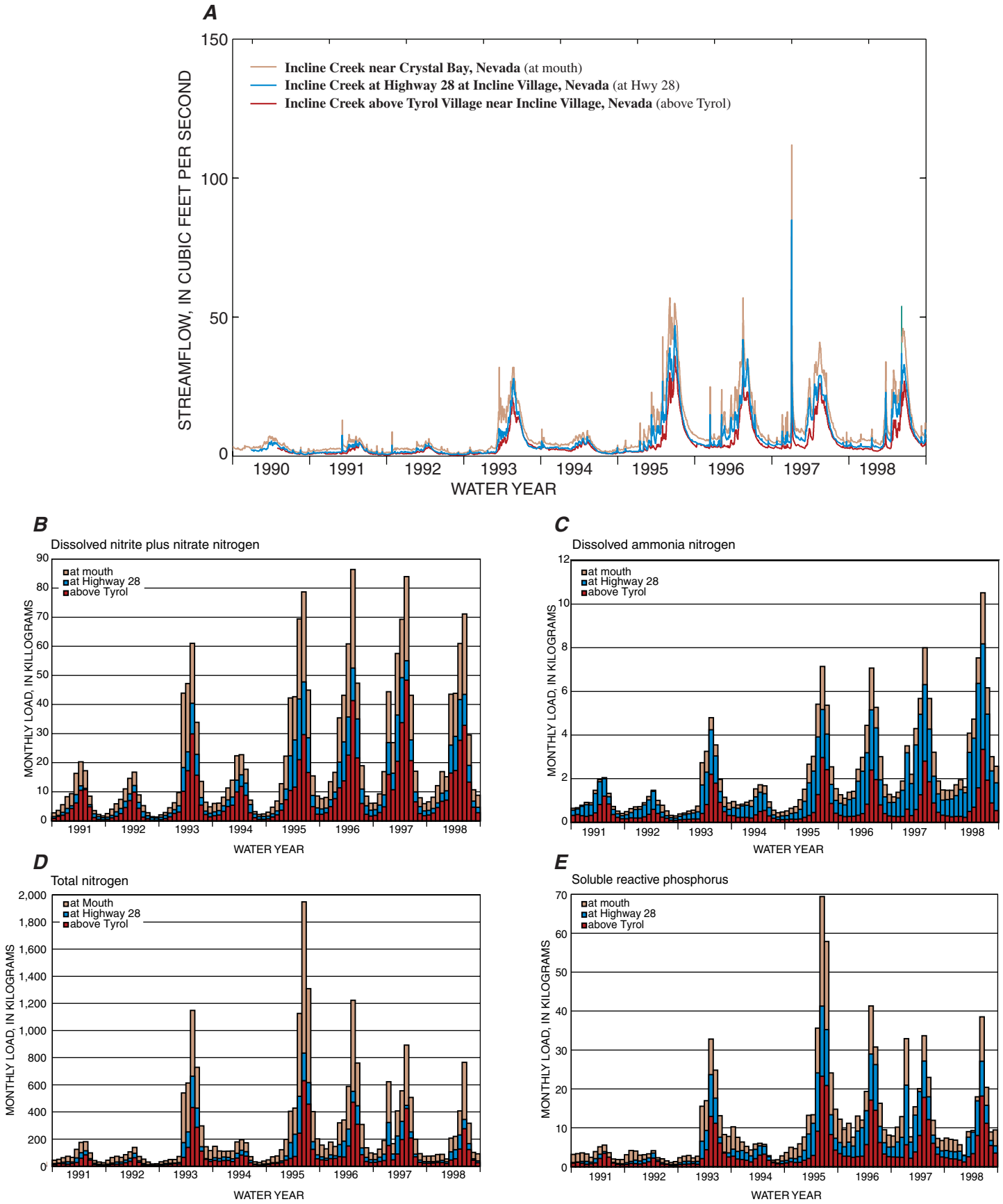

Figure 30. Within-watershed comparison of streamflow and nutrients and suspended-sediment concentrations at three Incline Creek watershed stations, water years 1991–98.

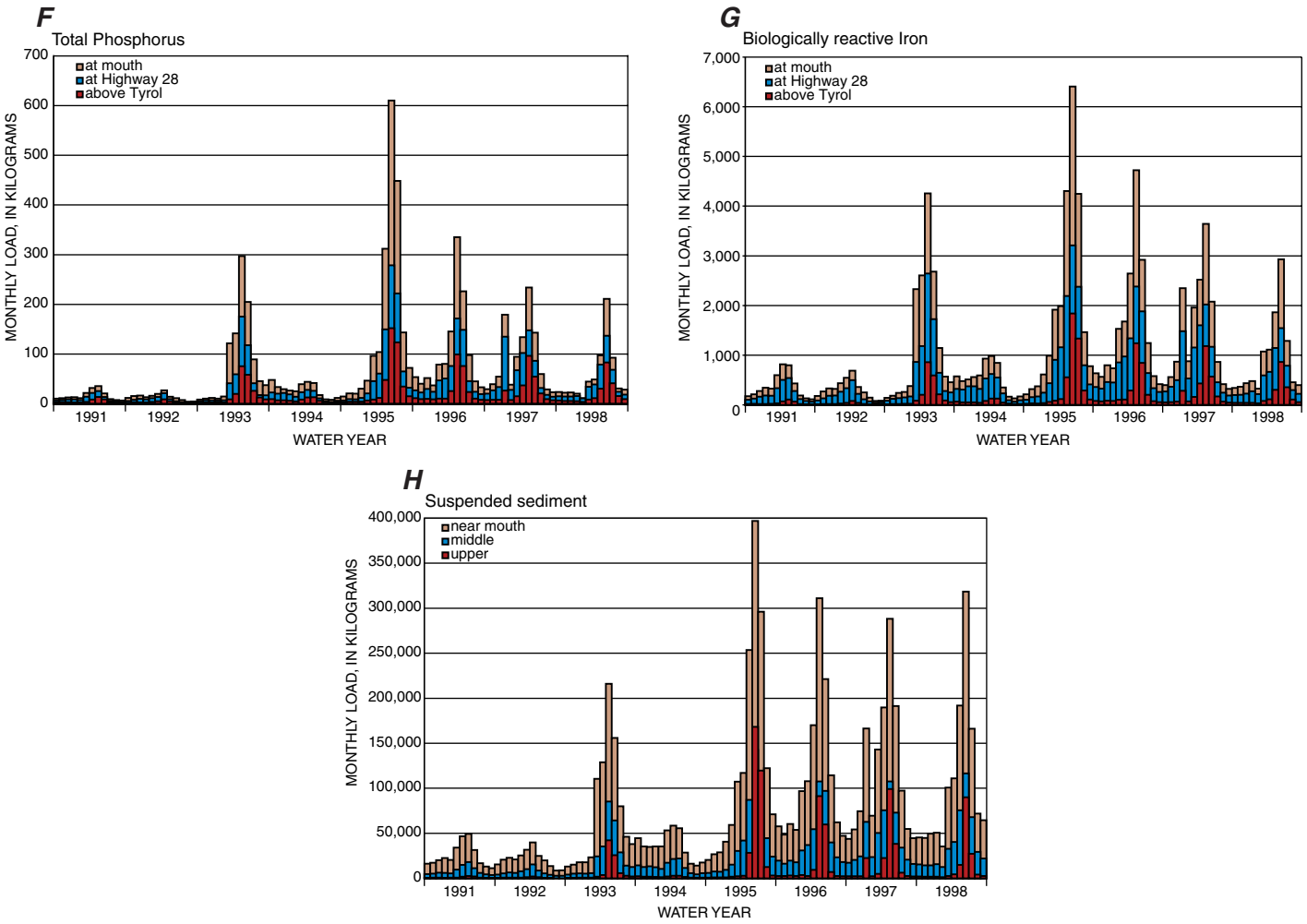

Figure 30. Continued.

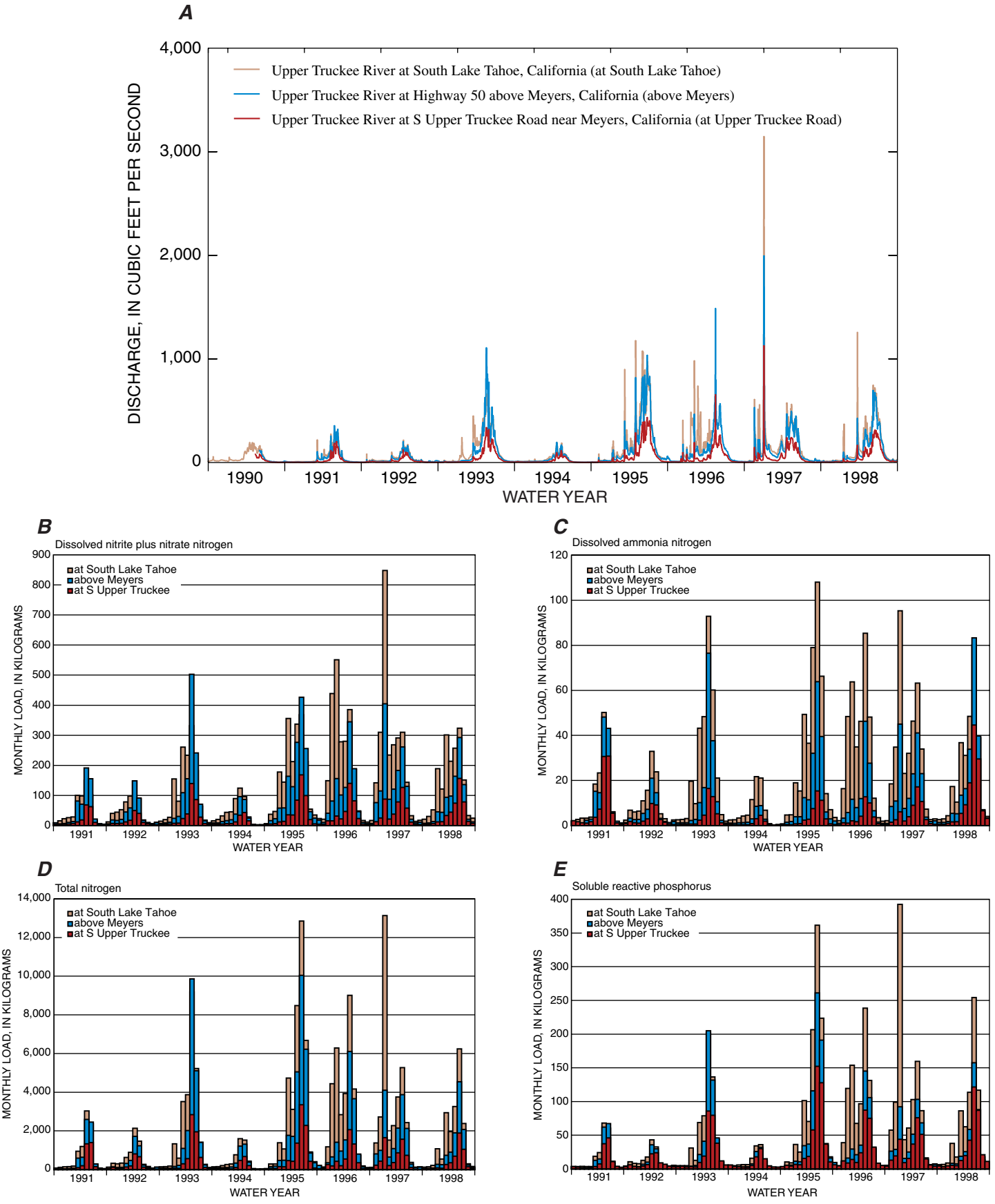

Figure 31. Within-watershed comparison of streamflow and nutrients and suspended-sediment concentrations at three Upper Truckee River watershed stations, water years 1991–98.

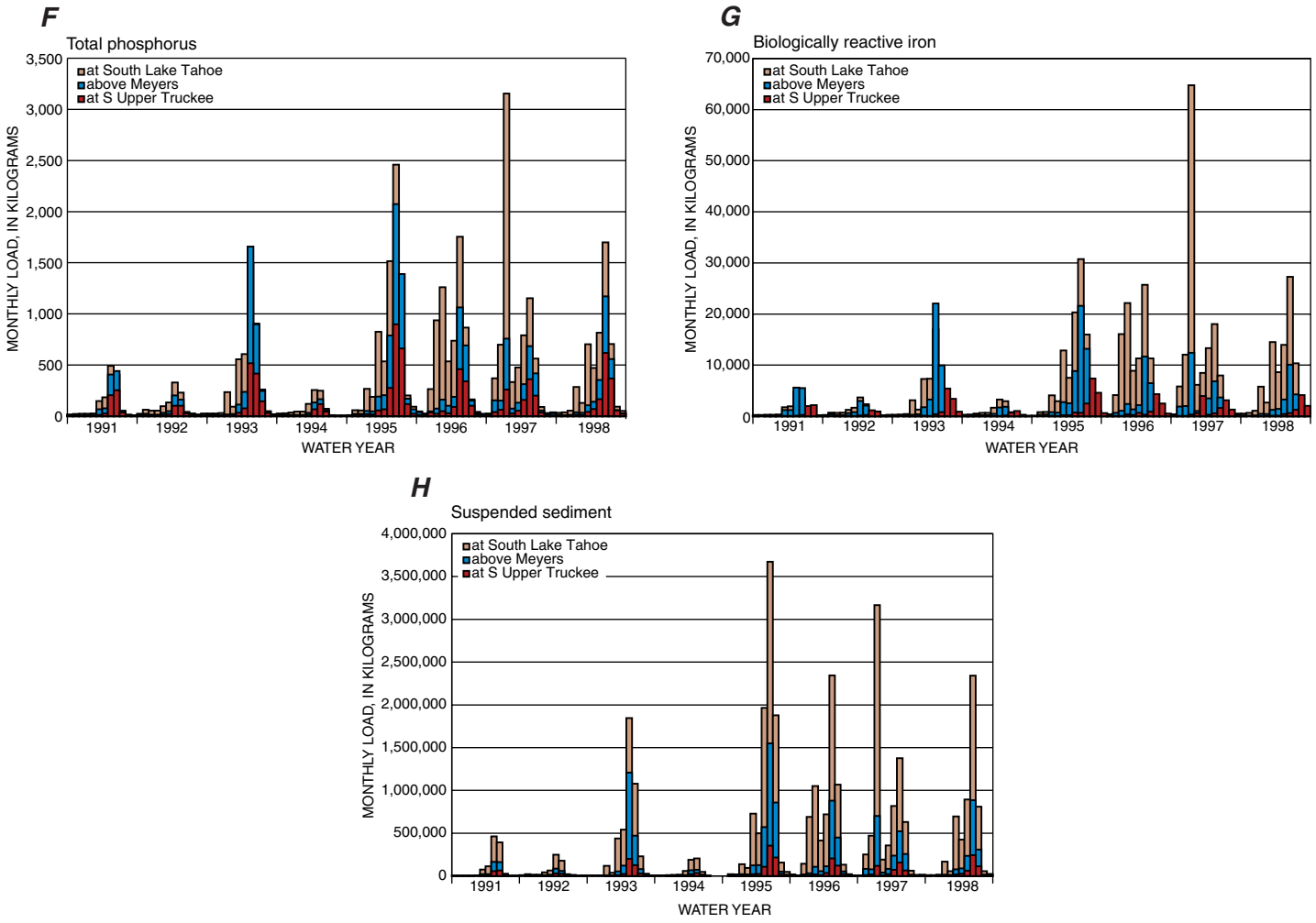

Figure 31. Continued.

Table 24. Average percent change of sums among the downstream, middle, and upstream stations for nutrient and suspended-sediment monthly loads and runoff, for the periods of comparison, in the five multiple-station watersheds in the Lake Tahoe Basin, California and Nevada

[Symbol: *, comparison between downstream (near mouth) and two combined upstream (input) stations]

Multiple station watershed	Downstream (near mouth) stations	Middle stations	Upstream (input) stations	Total percent
Incline Creek	38	31	31	100
Edgewood Creek	(46)*	(43 = input)	11	100
Trout Creek	41	36	23	100
Upper Truckee River	42	34	24	100
Ward Creek	19	34	47	100

mined by averaging the ranks of all seven constituents for each watershed station and ranking these average ranks among the stations.

Median monthly yields for nutrients and suspended sediment for the 10 primary stations are listed with load summary data in table 18 and shown in figures 32–38. Unit values for average annual runoff for the period of record are listed in table 4 and shown in figure 10.

Primary Stations

Comparing primary stations for the study period (1988–98), Incline Creek near Crystal Bay had the largest median monthly yields for dissolved nitrite plus nitrate, 0.56 kg/km^2/mo, and soluble reactive phosphorus, 0.30 kg/km^2/mo. Third Creek had the largest median monthly yields for total nitrogen, 7.50 kg/km^2/mo, total phosphorus, 1.55 kg/km^2/mo, biologically reactive iron, 45.9 kg/km^2/mo, and suspended sediment, 1,360 kg/km^2/mo. Edgewood Creek at Stateline had the largest yield for ammonia, 0.12 kg/km^2/mo. Logan House Creek had the smallest yields for all nutrients and sediment with nitrite plus nitrate, 0.04 kg/km^2/mo, ammonia, 0.01 kg/km^2/mo, total nitrogen, 0.49 kg/km^2/mo, soluble reactive phosphorus, 0.01 kg/km^2, total phosphorus, 0.05 kg/km^2/mo, biologically reactive iron, 0.24 kg/km^2/mo, and suspended sediment, 17.3 kg/km^2/mo.

Median monthly suspended-sediment yields were highest for Third Creek, followed in order by Incline Creek, Blackwood Creek, and the Upper Truckee River. These yields are similar to another suspended-sediment study from 1981 to 1985 on nine Lake Tahoe Basin watersheds by Hill and Nolan (1988). This study found that the highest annual suspended-sediment yields were from, in descending order, Blackwood Creek, Ward Creek, Upper Truckee River, and Third Creek. Note that eight of their stations are existing LTIMP stations.

Ranks of median monthly yields for each primary station for each constituent are shown along with yields in figures 31–37. The overall average ranks are shown in figure 39. Incline Creek had the highest average rank of median monthly yield and Logan House Creek near Glenbrook had the lowest. Edgewood Creek actually came in third, but was downgraded to fourth as the comparison period for that watershed was only from 1992 to 1998.

Within-Watershed Stations

Median monthly nutrient and suspended-sediment yields and average annual unit runoff data for the five multiple stations watersheds are presented with the load summary data in tables 19–23. All five multiple-station watersheds decreased in unit runoff from the upstream station to the downstream station, except Edgewood Creek. For example, Incline Creek decreased from 1,180 acre-ft/mi^2 at the upstream site to 1,040 acre-ft/mi^2 at the middle station to 930 acre-ft/mi^2 at the downstream (near mouth) station, which is typical for the smaller streams. Yields for dissolved nitrite plus nitrate nitrogen increased slightly to moderately in downstream order in four of five watersheds. Ward Creek stations decreased from 0.50 to 0.22 kg/km^2/mo between the upstream and downstream stations. Dissolved ammonia nitrogen yields increased slightly in four watersheds between the upstream and downstream stations, with Ward Creek showing a decrease. Total nitrogen and total phosphorus yields increased between the upstream and downstream stations in four watersheds but decreased in Edgewood Creek. Soluble reactive phosphorus yields increased in Incline, Edgewood and Ward Creeks and decreased in Trout Creeks and Upper Truckee River. Iron increased between the upstream and downstream stations in all five watersheds while suspended sediment increased in Incline, Trout and Upper Truckee River watersheds and decreased in the Ward and Edgewood Creeks.

Trends in Concentrations

Trends in constituent concentrations over time from the Seasonal-Kendall test for all 10 primary and 10 secondary stations are summarized in table 25 and for the 10 primary stations by constituent in figures 40–46. Over time 69 percent of constituent concentrations decreased, 26 percent had no significant trend, and 5 percent increased.

Comparison of the primary stations (fig. 40) showed five stations with decreasing trends in dissolved nitrite plus nitrate nitrogen concentrations and five stations with no significant trends. Seven stations had decreasing trends in dissolved ammonia nitrogen concentrations and three stations had no significant trends. Six stations had decreasing trends in total nitrogen concentrations and four had no significant trends. Four stations had decreasing trends in soluble reactive phosphorus concentrations and six had no significant

Table 25. Trends, P values, and probability plot correlation coefficient (PPCC) values from Seasonal Kendall and ESTIMATOR results for 10 primary and 10 secondary LTIMP stations in the Lake Tahoe Basin, California and Nevada

[Symbols: *, P value <.05 = significant trend; **, P value >.05 to <.10 = less-significant trend; ***, P value >.10 = no significant trend; —, no significant trend]

Constituent	Seasonal Kendall trend	Seasonal Kendall P value	Estimator trend	Estimator P value	PPCC
Third Creek near Crystal Bay					
Dissolved nitrite + nitrate	—	0.102***	positive	0.866***	0.99
Dissolved ammonia	negative	.005*	negative	.000*	.99
Total nitrogen	negative	.021*	negative	.000*	.98
Soluble reactive phosphorus	—	.423***	—	.303***	.99
Total phosphorus	negative	.021*	—	.296***	.99
Biologically reactive iron	negative	.002*	positive	.000*	.98
Suspended sediment	negative	.070**	positive	.000*	.99
Incline Creek near Crystal Bay					
Dissolved nitrite + nitrate	negative	.003*	negative	.813***	.98
Dissolved ammonia	negative	.011*	negative	.004*	.99
Total nitrogen	negative	.051**	positive	.000*	.98
Soluble reactive phosphorus	negative	.019*	negative	.002*	.81
Total phosphorus	—	.260***	—	.107***	.99
Biologically reactive iron	—	.535***	negative	.001*	.97
Suspended sediment	—	.110***	negative	.000*	.98
Incline Creek at Highway 28					
Dissolved nitrite + nitrate	negative	.002*	—	.526***	.98
Dissolved ammonia	negative	.013*	—	.488***	.98
Total nitrogen	negative	.002*	negative	.000*	.97
Soluble reactive phosphorus	negative	.088**	—	.720***	.96
Total phosphorus	negative	.009*	negative	.000*	.97
Biologically reactive iron	negative	.003*	negative	.000*	.96
Suspended sediment	negative	.036*	negative	.000*	.98
Incline Creek above Tyrol Village					
Dissolved nitrite + nitrate	negative	.000*	—	.608***	.98
Dissolved ammonia	negative	.002*	negative	.010*	.98
Total nitrogen	negative	.001*	negative	.000*	.97
Soluble reactive phosphorus	negative	.001*	negative	.026*	.95
Total phosphorus	negative	.000*	negative	.001*	.94
Biologically reactive iron	negative	.001*	negative	.057**	.94
Suspended sediment	negative	.002*	negative	.000*	.98
Glenbrook Creek at Glenbrook					
Dissolved nitrite + nitrate	negative	.002*	negative	.048*	.96
Dissolved ammonia	negative	.001*	negative	.000*	.99
Total nitrogen	negative	.000*	negative	.000*	.96
Soluble reactive phosphorus	—	.304***	—	.217***	.98
Total phosphorus	negative	.025*	negative	.001*	.96
Biologically reactive iron	negative	.037*	negative	.001*	.96
Suspended sediment	—	.713***	negative	.010*	.98
Logan House Creek near Glenbrook					
Dissolved nitrite + nitrate	—	.168***	—	.444***	.98
Dissolved ammonia	negative	.003*	negative	.000*	.92
Total nitrogen	negative	.009*	negative	.000*	.98

Table 25. Trends, P values, and probability plot correlation coefficient (PPCC) values from Seasonal Kendall and ESTIMATOR results for 10 primary and 10 secondary LTIMP stations in the Lake Tahoe Basin, California and Nevada—Continued

Constituent	Seasonal Kendall trend	Seasonal Kendall P value	Estimator trend	Estimator P value	PPCC
Logan House Creek near Glenbrook					
Soluble reactive phosphorus	negative	.001*	negative	.000*	.74
Total phosphorus	negative	.000*	negative	.000*	.99
Biologically reactive iron	negative	.008*	negative	.021*	.97
Suspended sediment	negative	.005*	negative	.000*	.86
Edgewood Creek at Stateline					
Dissolved nitrite + nitrate	negative	.052**	—	.262***	.96
Dissolved ammonia	—	.187***	—	.626***	.99
Total nitrogen	negative	.002*	negative	.000*	.99
Soluble reactive phosphorus	negative	.011*	—	.192***	.98
Total phosphorus	negative	.011*	negative	.060**	.95
Biologically reactive iron	negative	.004*	negative	.077**	.94
Suspended sediment	negative	.065**	negative	.007*	.97
Edgewood Creek at Palisade Drive					
Dissolved nitrite + nitrate	negative	.008*	—	.134***	.99
Dissolved ammonia	negative	.004*	—	.375***	.99
Total nitrogen	negative	.017*	negative	.000*	.95
Soluble reactive phosphorus	negative	.007*	negative	.053**	.93
Total phosphorus	negative	.001*	negative	.000*	.91
Biologically reactive iron	negative	.001*	negative	.008*	.92
Suspended sediment	negative	.004*	negative	.000*	.95
Eagle Rock Creek near Stateline					
Dissolved nitrite + nitrate	negative	.080**	negative	.071**	.99
Dissolved ammonia	negative	.004*	negative	.023*	.98
Total nitrogen	—	.552***	negative	.000*	.85
Soluble reactive phosphorus	—	.159***	negative	.066**	.92
Total phosphorus	negative	.011*	—	.863***	.80
Biologically reactive iron	—	.216***	negative	.007*	.84
Suspended sediment	negative	.074**	negative	.000*	.89
Trout Creek at South Lake Tahoe					
Dissolved nitrite + nitrate	—	.479***	negative	.000*	.99
Dissolved ammonia	—	.115***	negative	.000*	.99
Total nitrogen	—	.227***	negative	.236***	.98
Soluble reactive phosphorus	—	.374***	—	.662***	.96
Total phosphorus	negative	.044*	negative	.000*	.98
Biologically reactive iron	—	.112***	—	.832***	.96
Suspended sediment	—	1.00***	negative	.000*	.99
Trout Creek at Pioneer Trail					
Dissolved nitrite + nitrate	negative	.038*	-negative	.055**	.98
Dissolved ammonia	negative	.014*	negative	.020*	.99
Total nitrogen	negative	.060**	negative	.000*	.93
Soluble reactive phosphorus	negative	.020*	—	.816***	.98
Total phosphorus	negative	.016*	negative	.000*	.89
Biologically reactive iron	negative	.011*	negative	.000*	.91
Suspended sediment	negative	.003*	negative	.000*	.97

Table 25. Trends, P values, and probability plot correlation coefficient (PPCC) values from Seasonal Kendall and ESTIMATOR results for 10 primary and 10 secondary LTIMP stations in the Lake Tahoe Basin, California and Nevada—Continued

Constituent	Seasonal Kendall trend	Seasonal Kendall P value	Estimator trend	Estimator P value	PPCC
Trout Creek at U.S. Forest Service Rd. 12N01					
Dissolved nitrite + nitrate	negative	.000*	negative	.076**	.99
Dissolved ammonia	negative	.007*	negative	.000*	.99
Total nitrogen	negative	.001*	negative	.000*	.98
Soluble reactive phosphorus	negative	.029*	negative	.918***	.97
Total phosphorus	negative	.000*	negative	.003*	.95
Biologically reactive iron	negative	.045*	negative	.000*	.87
Suspended sediment	negative	.001*	negative	.000*	.93
Upper Truckee River at South Lake Tahoe					
Dissolved nitrite + nitrate	negative	.000*	negative	.000*	.99
Dissolved ammonia	—	.136***	negative	.000*	.99
Total nitrogen	negative	.006*	negative	.000*	.98
Soluble reactive phosphorus	negative	.036*	negative	.000*	.99
Total phosphorus	negative	.005*	negative	.000*	.98
Biologically reactive iron	—	.404***	—	.385***	.96
Suspended sediment	negative	.005*	negative	.000*	.98
Upper Truckee River at Highway 50 above Meyers					
Dissolved nitrite + nitrate	negative	.000*	negative	.000*	.98
Dissolved ammonia	negative	.036*	—	.198***	.98
Total nitrogen	negative	.000*	negative	.000*	.97
Soluble reactive phosphorus	negative	.000*	negative	.000*	.97
Total phosphorus	positive	.000*	negative	.000*	.95
Biologically reactive iron	negative	.000*	negative	.000*	.94
Suspended sediment	negative	.000	negative	.000	.96
Upper Truckee River at South Upper Truckee Road					
Dissolved nitrite + nitrate	negative	.001*	—	.528***	.99
Dissolved ammonia	negative	.041*	negative	.006*	.98
Total nitrogen	negative	.001*	negative	.000*	.97
Soluble reactive phosphorus	—	.193***	—	.628***	.97
Total phosphorus	negative	.001*	negative	.000*	.96
Biologically reactive iron	negative	.028*	negative	.000*	.94
Suspended sediment	negative	.000*	negative	.000*	.98
General Creek near Meeks Bay					
Dissolved nitrite + nitrate	—	.935***	negative	.002	.99
Dissolved ammonia	negative	.003*	negative	.000*	.97
Total nitrogen	—	.893***	—	.565***	.99
Soluble reactive phosphorus	—	.603***	—	.556***	.99
Total phosphorus	negative	.004*	—	.182***	.83
Biologically reactive iron	positive	.003*	positive	.000*	.97
Suspended sediment	positive	.000*	positive	.000*	.99
Dissolved nitrite + nitrate	—	.279***	negative	.001*	.89
Blackwood Creek near Tahoe City					
Total nitrogen	—	.447***	—	.136***	.99
Dissolved ammonia	negative	.000*	negative	.000*	.79

Table 25. Trends, P values, and probability plot correlation coefficient (PPCC) values from Seasonal Kendall and ESTIMATOR results for 10 primary and 10 secondary LTIMP stations in the Lake Tahoe Basin, California and Nevada—Continued

Constituent	Seasonal Kendall trend	Seasonal Kendall P value	Estimator trend	Estimator P value	PPCC
Blackwood Creek near Tahoe City					
Soluble reactive phosphorus	—	.396***	positive	.000*	.99
Total phosphorus	negative	.020*	negative	.003*	.97
Biologically reactive iron	positive	.018*	positive	.000*	.99
Suspended sediment	positive	.000*	positive	.000*	.99
Ward Creek at State Highway 89					
Dissolved nitrite + nitrate	negative	.041*	negative	.000*	.99
Dissolved ammonia	negative	.044*	negative	.000*	.98
Total nitrogen	—	.893***	negative	.013	.99
Soluble reactive phosphorus	—	.462***	—	.962***	.83
Total phosphorus	negative	.007*	negative	.000*	.96
Biologically reactive iron	positive	.004*	positive	.000*	.99
Suspended sediment	positive	.058**	positive	.000*	.98
Ward Creek at Stanford Rock Crossing					
Dissolved nitrite + nitrate	negative	.035*	negative	.000	.99
Dissolved ammonia	negative	.084***	—	.796***	.99
Total nitrogen	negative	.043*	negative	.000	.98
Soluble reactive phosphorus	negative	.050*	—	.992***	.97
Total phosphorus	—	.154***	—	.507***	.98
Biologically reactive iron	negative	.060**	negative	.000	.98
Suspended sediment	—	.238***	negative	.072**	.98
Ward Creek below confluence					
Dissolved nitrite + nitrate	—	.154***	negative	.000*	.98
Dissolved ammonia	—	.822***	positive	.082**	.99
Total nitrogen	negative	.060**	negative	.000*	.97
Soluble reactive phosphorus	negative	.084**	negative	.003	.98
Total phosphorus	—	.154***	negative	.098**	.91
Biologically reactive iron	—	.940***	—	.234***	.96
Suspended sediment	—	.822***	negative	.001	.98

Trend summary:	Number
Both negative	77
Both positive	6
Both undetected	16
1 negative/1 undetected	35
1 positive/1 undetected	2
1 positive/1 negative	4
Total	**140**

trends. Nine of the 10 stations had decreasing trends in total phosphorus concentrations and one had no significant trend. Three stations in General, Blackwood, and Ward Creeks had increasing trends in biologically reactive iron, four had decreasing trends, and three had no significant trends. The same three stations had increasing trends in suspended-sediment concentrations, four stations had decreasing trends, and three stations had no significant trends.

Decreasing trends in undeveloped watersheds, such as Logan House Creek, may be due to a variety of causes, although none are clearly indicated. Potential causes include changes in weather patterns during the study period, such as the lack of intense summer thunderstorms. Cooler spring snowmelt periods during the latter years of the study led to longer, more moderate runoff patterns, in general, and may have resulted in less channel erosion. In addition, decreasing trends for developed watersheds also may be due to the increased restoration projects and installation of best management practices, resulting in overall greater efficiency in these watersheds. Increasing concentrations in biologically reactive iron and suspended sediment at the three stations noted previously seem to be based primarily on samples collected during and after the January 1997 flood.

SUMMARY

Concentrations and loads of six nutrients and suspended sediment and rates of streamflow varied widely in the 14 sampled watersheds of the Lake Tahoe Basin. Greater amounts of precipitation generally fall on the western side of Lake Tahoe Basin and the streamflow runoff and nutrient and suspended-sediment concentrations and loads reflect that.

The highest mean annual runoff and instantaneous peak and measured streamflow for the 20 primary and secondary stream gaging stations were found at the Upper Truckee River at South Lake Tahoe, which has the largest drainage area. The highest unit runoff occurred at Blackwood Creek. The lowest runoff, instantaneous peak and measured streamflow, and unit runoff were all found at Logan House Creek, which has the smallest drainage area.

Water-quality data mostly fell within expected levels for the sampled stations in the LTIMP network, with the exception of elevated pH values for the Edgewood Creek at Lake Tahoe. Field pH values there ranged from 7.3 to 10.6 with a median of 8.8. Field pH's were higher on the east side of the basin, but consistently less than the median and maximum values observed at Edgewood Creek.

The highest concentrations for four of the six nutrients (dissolved nitrite plus nitrate nitrogen, dissolved ammonia nitrogen, total phosphorus, and biologically reactive iron) and suspended sediment, and second highest concentrations of 2 other nutrients (soluble reactive phosphorus and total ammonia and organic nitrogen) were found at a miscellaneous urban runoff station (Highway 50 Culvert to Edgewood Creek). The highest concentrations of other nutrients were found at another miscellaneous urban runoff station (Tributary to Edgewood Creek above clubhouse) for soluble reactive phosphorus and Third Creek near Crystal Bay (a primary station) for total ammonia and organic nitrogen. The higher total concentrations usually occurred during summer thunderstorm events and during rain-on-snow events in the winter/ spring periods. Lowest total constituent concentrations occurred during fall and winter periods, when streamflow was at its lowest. Dissolved constituent concentrations and specific conductance tend to increase in the low flow periods and tend to be lowest during prolonged snowmelt period. Concentrations of dissolved ammonia nitrogen were low for the study and had a large number of below detection limit values (less than 0.003 mg/L).

The emphasis in LTIMP sampling was placed on storm runoff and spring snowmelt runoff. As a result, samples collected under this study may have higher maximum concentration values, medians, and sums than from other water quality studies in the basin.

The Upper Truckee River watershed shows the largest monthly loads of all nutrients and suspended sediment of the 10 primary watersheds. The Upper Truckee River is the largest watershed and has the greatest annual runoff of the monitored watersheds in the Lake Tahoe Basin. Factors contributing to this high runoff are that the Upper Truckee watershed, located on the west side of the Lake Tahoe Basin, receives among the highest amounts of precipitation in the basin and has large amounts of developed area. The smallest loads for the 10 primary watersheds are from Logan House Creek, which is the smallest of the watersheds and has the least annual runoff for the 10 monitored watersheds. Logan House Creek generally is undeveloped (at least above the sampling station) watershed.

The highest monthly loads for the 10 primary watersheds generally occurred during snowmelt in June 1995 or January 1997, which included a major rain-on-snow event. The lowest monthly loads occurred during base-flow periods in August-September 1992, a drought year. Median monthly loads for the 10 primary watersheds also showed seasonality patterns, with most of the loading occurring during the spring snow-melt period (April, May, June). The smaller loads occurring during the summer (July, August, and September) and fall (October, November, and December) periods.

The largest median monthly yields occurred in the northeast part of the basin in the Incline Village area. Third Creek near Crystal Bay had the highest yields for total nitrogen, total phosphorus, biologically reactive iron and suspended sediment. Incline Creek near Crystal Bay had the highest yields for nitrite plus nitrate and soluble reactive phosphorus. Edgewood Creek at Stateline had the highest yield for ammonia. Logan House Creek had the lowest yields for all nutrients and suspended sediment. Of the 10 primary watersheds, the higher yields were from watersheds which receive greater precipitation and are more developed. The lowest yields were from two watersheds which receive less precipitation and are less developed.

The 10 primary watersheds were ranked based on nutrient and suspended-sediment yields. The rankings for the primary watersheds are listed from highest to lowest: Incline Creek, Third Creek, Blackwood Creek, Edgewood Creek, Upper Truckee River, Trout Creek, Ward Creek, General Creek, Glenbrook Creek, and Logan House Creek.

Constituent concentrations in the 10 primary watersheds showed decreasing or no significant trends, with the exception for biologically reactive iron and suspended-sediment concentrations. These two constituent concentrations decreased or were undetected at 7 of the 10 stations and increased at 3 stations. Decreasing trends for developed watersheds may be due to restoration projects or the introduction of best management practices. Causes of decreases in relatively undeveloped watersheds are unclear, but may be related to climatic variations. Increased trends of concentrations likely are influenced by samples collected during and after a large flood event in January 1997.

REFERENCES CITED

Boughton, C.J., Rowe, T.G., Allander, K.K., and Robledo, A.R., 1997, Stream and ground water monitoring program, Lake Tahoe Basin, Nevada and California: U.S. Geological Survey Fact Sheet FS-100-97, 6 p.

Buchanan, T.J., and Somers, W.P., 1969, Discharge measurements at gaging stations: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A8, 65 p.

Cartier, K.D., Peltz, L.A., and Long, Kati, 1995, Hydrologic basins and hydrologic-monitoring sites of Lake Tahoe Basin, California and Nevada. U.S. Geological Survey Open-File Report 95-316, 1 sheet.

Cartier, K.D., Peltz, L.A., and Smith, J.L., 1994, Development and documentation of spatial databases for the Lake Tahoe Basin, California and Nevada: U.S. Geological Survey Open-File Report 93-4182, 65 p.

Cohn, T., 1988, Adjusted maximum likelihood estimations of the moments of lognormal populations from type I censored samples: U.S. Geological Survey Open-File Report 88-350, 34 p.

Cohn, T.A., DeLong, L.L., Gilroy, E.J., Hirsch, R.M., and Wells, D.K., 1989, Estimating constituent loads: Water Resources Research, v. 25(5), p. 937–942.

Cohn, T.A., Caulder, D.L., Gilroy, E.J., Zynjuk, L.D., and Summers, R.M., 1992, The validity of a simple statistical model for estimating fluvial constituent loads: an empirical study involving nutrient loads entering Chesapeake Bay: Water Resources Research, v. 28(9), p. 2353–2364.

Crawford, C.G., 1996, Estimating mean constituent loads in rivers by the rating-curve and flow-duration, rating curve methods: Bloomington, Indiana, Indiana University, Ph.D. dissertation, 245 p.

Crippen J.R., and Pavelka, B.R., 1970, The Lake Tahoe Basin, California–Nevada: U.S. Geological Survey Water-Supply Paper 1972, 56 p.

Edwards, T.K., and Glysson, G.D., 1988, Field methods for measurement of fluvial sediment: U.S. Geological Survey Open-File Report 86-531, 118 p.

Glancy, P.A., 1988, Streamflow, sediment transport, and nutrient transport at Incline Village, Lake Tahoe, Nevada, 1970–73: U.S. Geological Survey Water-Supply Paper 2312, 53 p.

Goldman, C.R., and Byron, E.R., 1986, Changing water quality at Lake Tahoe—The first five years of the Lake Tahoe Interagency Monitoring Program: Tahoe Research Group, Institute of Ecology, University of California at Davis, 12 p.

Guy, H.P., 1969, Laboratory theory and methods for sediment analysis: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. C1, 58 p.

Goldman, C.R., and Byron, E.R., 1986, Changing water quality at Lake Tahoe—The first five years of the Lake Tahoe Interagency Monitoring Program: Tahoe Research Group, Institute of Ecology, University of California at Davis, 12 p.

Guy, H.P., 1969, Laboratory theory and methods for sediment analysis: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. C1, 58 p.

Helsel, D.R., and Hirsch, R.M., 1992, Statistical methods in water resources: Studies in Environmental Science 49, Amsterdam, Elsevier, 522 p.

Hill, B.R., and Nolan, K.M., 1988, Suspended-sediment factors, Lake Tahoe Basin, California-Nevada, *in* Poppoff, I.G., Goldman, C.R., Loeb, S.L., and Leopold, L.B., eds., Proceedings, International Mountain Watershed Symposium, Lake Tahoe, June 8–10, 1988: South Lake Tahoe, Calif., Tahoe Resource Conservation District, p. 179–189.

Hunter, D.A., Reuter, J.E., and Goldman, C.R., 1993, Standard operating procedures—Lake Tahoe Interagency Monitoring Program: University of California at Davis Tahoe Research Group, 79 p.

Jeton, A.E., 1999, Precipitation-runoff simulations for the Lake Tahoe Basin, California and Nevada: U.S. Geological Survey Water-Resources InvestigationsReport 99-4110, 61 p.

Jorgensen, L.N., Seacer, A.L., and Kaus, S.J., 1978, Hydrologic basins contributing to outflow from Lake Tahoe, California–Nevada: U.S. Geological Survey Hydrologic Investigations Atlas HA-587, scale 1:62,500.

Kennedy, E.J., 1983, Computation of continuous records of streamflow: U. S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A13, 53 p.

Rowe, T.G., 1999, Comparison of water quality for upstream and downstream sites in the Incline Creek watershed, Lake Tahoe Basin, Nevada, 1990–98: Sixty-seventh Annual Meeting, Western Snow Conference, South Lake Tahoe, Calif., April 1999, Proceedings, p. 35–44.

——— 2000, Lake Tahoe Interagency Monitoring Program: Tributary sampling design, sites, and periods of record: U.S. Geological Survey Fact Sheet FS-138-00, 4 p.

Rowe, T.G., Rockwell, G.R., and Hess, G.W., 1998, Flood of January 1997 in the Lake Tahoe Basin, California and Nevada: U.S. Geological Survey Fact Sheet FS-005-98, 2 p.

Rowe, T.G., and Stone, J.C., 1997, Selected hydrologic features of the Lake Tahoe Basin, California and Nevada: U.S. Geological Survey Open-File Report 97-384, 1 sheet.

Smith, J.L., Stone, J.C., Rowe, T.G., and Gardener, J.V., 1999, Selected hydrologic features of the Lake Tahoe Basin and surrounding area, California and Nevada, 1998 U.S. Geological Survey Water-Resources Investigations Report 99-4031, 1 sheet.

Thomas, B.E., Hjalmarson, H.W., and Waltemeyer, S.D., 1997, Methods for estimating magnitude and frequency of floods in the southwestern United States: U.S. Geological Survey Water-Supply Paper 2433, 195 p.

U.S. Geological Survey, 1989–99, Water resources data, Nevada, water years 1988–99: U.S. Geological Survey Water-Resources Data Report, published annually.

U.S. Geological Survey, 1998, National field manual for the collection of water-quality data: Techniques of Water-Resources Investigations — Handbook for Water-Resources Investigations, book 9, chaps. A1–A9, 2 volumes.

U.S. Interagency Advisory Committee on Water Data, 1982, Guidelines for determining flood flow frequency: Bulletin 17B of the Hydrology Subcommittee: Reston, Va., U.S. Geological Survey, Office of Water Data Coordination, 183 p.

Walker, W.W., 1996, Simplified procedures for euthrophication assessment and prediction: User manual, Chapter 2 FLUX: U.S. Army Corp of Engineers, Water Operations Technical Support Program, Instruction report W-96-2, p. 2-1 to 2-61.

APPENDICES

APPENDIX 1

Water-Quality and Streamflow Information on the Internet

USGS/LTIMP water-quality data and daily, monthly, and annual mean streamflow and instantaneous streamflow measurements are available to the public through several USGS websites on the World Wide Web. Real-time and historical streamflow data and site information are available from the Nevada USGS National Water Information System (NWIS) site at: <http://water.usgs.gov/nv/nwis/>. This website includes information for Nevada and California stations in the Lake Tahoe Basin. Information also is accessible at the following websites: the USGS Nevada District at <http://nevada.usgs.gov>, the Lake Tahoe Data Clearinghouse at <http://tahoe.usgs.gov>, and the USGS California District NWIS at <http://water.usgs.gov/ca/nwis/>. Streamflow data by water year are published annually in the USGS Water Resources Data Report for Nevada and California.

APPENDIX 2

Estimated Nutrient and Suspended-Sediment Monthly Loads

Estimated nutrient daily and monthly loads from the ESTIMATOR program are listed in Appendix 2, with estimated standard errors, estimated standard error of prediction and 95-percent confidence intervals. Also listed in Appendix 2 are stimated suspended-sediment monthly loads from the FLUX program.

Appendix 2 is available on the Internet as a Microsoft Access database file. This file can be downloaded from the online version of this report, which is at URL: <http://pubs.water.usgs.gov/wri024030/>.